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MANUAL FOR SURVEY, INVESTIGATION AND PREPARATION OF ROAD PROJECTS

(Second Revision)

INDIAN ROADS CONGRESS
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3.	Secretary General	(Nirmal, S.K.), Indian Roads Congress, New Delhi

MANUAL FOR SURVEY, INVESTIGATION AND PREPARATION OF ROAD PROJECTS

1. INTRODUCTION

1.1 Preparation of highway projects involves a chain of activities, such as, study of road network, selection of alignment, conducting field surveys and investigations, preparation of various designs, reports, drawings, estimates, schedules and bid documents etc. To be compatible with technical requirements, specifications and standards, and to be consistent with economy, it is essential that every project is prepared after thorough investigations and collection of all the relevant information and complete evaluation of all possible alternatives.

1.2 The extent and quality of studies and investigations have a strong influence on selection of the most cost-effective design, estimation of quantities, cost and execution of the job itself. As such, accuracy and completeness of surveys deserve special attention in project preparation. This objective can be achieved by carrying out the project preparation work either departmentally or with the help of consultants. In any case, it should be ensured that experts having the required knowledge are deployed on the work. Use of new technology, modern instruments and survey techniques ensure high degree of accuracy and can speed up the work. Quality Assurance Plan, consisting of formats for conducting various surveys and investigations, and checklists for ensuring that the designs and reports are complete, has to be drawn before the start of field investigations.

1.3 Adequate funds should be earmarked for the work of surveys, investigations and project preparation. Realistic estimation of funds and time required for project preparation, will go a long way in making the project preparation a success. It will be found in the long run that, such investment pays more than for itself in the form of well prepared and cost-effective projects, orderly schedule of work and timely completion.

1.4 Systematic presentation of project details is no less important. The project document is the very basis of technical, administrative and financial sanction of a project. It is also crucial for accurate execution of work in the field. The project report should, therefore, be comprehensive enough for proper appreciation of the proposals as well as for easy understanding of the details. This Manual lays down guidelines both for surveys & investigations and presentation of the project details.

1.5 The Indian Roads Congress first published this manual in 1977 and revised it in 2001. Since then, considerable experience has been gained by the Highway Departments and Consultants in this field, making it necessary to revise the manual. The work was taken up by the G-1 Committee commissioned for the purpose of Project Preparation, Contract Management, Quality Assurance and Public Private Partnership Committee of the Indian Roads Congress.

1.6 The draft document was deliberated in a series of meetings. The G-1 Committee finally approved the draft document in its meeting held on 23rd November, 2019 and recommended to submit the final draft to IRC for placing before the GSS Committee.

The Composition of G-1 Committee is as given below:

Singh, B.N.	.....	Convenor
Padhy, L.P.	.....	Co-Convenor
Nirmal, S.K.	.....	Member Secretary

Members

Aggarwal, Varun	M. Kishore Kumar
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Kumar, Ashok	Sinha, N.K.

Ex-Officio Members

President, (Basar, Toli)	DG(RD) & SS, MoRTH (Pandey, I.K.)

Secretary General, IRC
(Nirmal, S.K.)

The General Specifications & Standards Committee considered and approved the draft document in its meeting held on 6th December, 2019 for placing it before Executive Committee and IRC Council. The Executive Committee in its meeting held on 19th December 2019 considered and approved the same for placing it before the Council. The Council of IRC in its 219th Council Meeting during the 80th Annual Session held at Patna (Bihar) on 19th December, 2019 considered and approved the doucument "Manual for Survey, Investigation and Preparation of Road Projects" for printing.

2. SCOPE

2.1 The manual deals with rural sections of Expressways, National Highways, State Highways and Major District Roads. It does not deal with Other District Roads and Village Roads, for which a reference may be made to "IRC:SP:20 Rural Roads Manual". However, the provisions and guidelines in this manual are expected to be applicable to a large extent to Urban Roads also. But for these roads, some additional requirements may be there, beyond those dealt in this document. The manual deals with new construction as well as improvements to existing roads under various modes of implementation including Item Rate, EPC, BOT, HAM etc. Special aspects of each mode have been highlighted wherever necessary.

2.2 IRC:SP:54 "Project Preparation Manual for Bridges" lays down guidelines to carry out investigations and designs for bridges and other structures. IRC:SP:13 stipulates the

requirements for design of culverts and minor bridges. For hill roads and road tunnels, reference may be made to IRC:52 "Recommendations about the Alignment, Survey and Geometric Design of Hill Roads", IRC:SP:48 "Hill Road Manual" and IRC:SP:91 “Guidelines for Road Tunnels”.

2.3 In order to ensure that the Surveys and Investigations, Feasibility Report and Detailed Project Report are complete, and no essential detail is missed, checklists for each of those activities are presented in the **Appendices – 6 and 9**.

2.4 It should be understood clearly that the extent of operations involved in surveys and investigations including the detailing of the individual aspects, would depend very much on the size and scope of each project and the class of the highway. Depending on the needs of the situation, one or more phases of investigations might be curtailed, telescoped or made more extensive than prescribed in this manual.

2.5 The order in which various surveys are discussed in this manual, should not be taken to mean that such work must strictly follow the same pattern or sequence. Some of the surveys could easily be initiated in advance and carried out simultaneously overlapping each other. For example, some results of soil and materials survey and study of cross-drainage structures would be needed as an essential input to the Feasibility Report. But more detailed investigations on these aspects may be continued in the detailed engineering phase. It should be up to the Client to exercise discretion and adopt a flexible approach, in respect of the extent and timing of surveys and investigations.

3. STAGES IN PROJECT PREPARATION

3.1 Stages

Broadly, the stages involved in the preparation and sanction of a Project are:

a) Pre-feasibility study
b) Feasibility Study
c) Detailed Project Report
d) Project Clearances

3.2 Pre-feasibility Study

3.2.1 It is necessary to prepare a pre-feasibility report to enable a funding agency or private financier or the Project Authority itself, to appreciate the broad features of the project, the levels of financial involvement and probable returns, based on which a decision can be taken on whether a detailed project report is needed. In case, it is found that the selected project is not technically feasible and/or financially viable, further studies/expenditure can be dispensed with.

3.2.2 At this stage, the viability of the Project has to be established by carrying out minimum surveys and investigations, in the least possible time. In order to do that, one has to largely depend on desktop study of the available data, exploration of alignments on the digital maps, and field reconnaissance to understand and decide the broad features of the proposed project highway.

3.2.3 Road Network in the project influence area shall be studied to understand the primary road corridor in which the project road falls, the alternative routes available between the proposed

origin and designation, and to assess the traffic likely to be attracted to the project road after its upgradation. Available traffic data on the project corridor and the region, can be collected from the field to estimate the possible revenue.

3.2.4 Various alignment options shall be prepared on digital maps in accordance with the criteria given in **Section 4**, and the optimum alignment shall be selected by the Client with due care to avoid environmentally and ecologically sensitive areas. The final alignment should aim at reduction in length, travel time, travel costs between the origin and destinations, life cycle costing etc., in addition to improvement in the existing geometric elements.

3.2.5 A minimum of reconnaissance survey, inventory and condition surveys of road and structures shall be conducted for the selected alignment, and based on these inventories, preliminary project upgradation proposals shall be made, and corresponding cost estimates shall be prepared. Traffic forecast and revenue estimation shall be done based on preliminary assessment of traffic from secondary data. And finally, economic and financial analysis shall be carried out using the projected traffic and preliminary cost of the project, based on which, viability shall be established.

3.2.6 Prefeasibility Report can be used by the Client to decide if the project is viable and if it should proceed further for feasibility study and preparation of detailed project report.

3.3 Feasibility Study

3.3.1 In the event that the Client decides to conduct feasibility study and prepare the detailed project report, it is required to carry out detailed surveys and investigations. Feasibility Study also aims to establish whether the proposal is acceptable in terms of soundness of engineering design and expected benefits from the project, for the investments involved, but on the basis of more detailed evaluation of the alignment and the required upgradation.

3.3.2 Detailed road & structure inventory and condition surveys, possible upgradation proposals, detailed topographic surveys, detailed traffic surveys and projections, soil, material and geo-technical investigations, environmental and social impact assessment, shall be carried out for the purpose of feasibility study. It is ideal to carry out sub-soil investigations at feasibility stage for a better and complete estimation of project viability. The payment schedule of the agencies shall be consistent with the degree of investigations conducted at this stage. A detailed scope of feasibility study is presented in **Section 10** of this Manual.

3.3.3 In feasibility study, project cost will be estimated based on the preliminary designs of the highway, structures and other miscellaneous components and facilities. Due to the advent of LiDAR, NSV and other modern survey equipment, one shall have to invariably establish the primary control points and capture the details of all the features along the alignment. LiDAR generates an exhaustive point cloud required for development of a digital terrain model at this point of time. So, only detailed structural designs remain to be carried out during the DPR stage, along with project clearances viz., environmental, forest, wild life, CRZ, including activities related to land acquisition, utility relocation estimates etc., which are generally taken up after receiving the in-principle or administrative approval from the competent authority of the Client.

3.4 Detailed Project Report

3.4.1 Detailed Project Report covers detailed design of highway including geometrical design, pavement design, and design of structures, drainage studies, preparation of detailed drawings,

estimates, implementation schedules and bid documents, Environment Impact Assessment (EIA) studies and preparation of Environment Management Plan (EMP), Social Impact Assessment (SIA) and preparation of Resettlement Action Plan (RAP). It shall be prepared in accordance with **Section 16** of this Manual. On the basis of the Detailed Project Report, Technical Approval and Financial Sanction (TA and FS) are accorded to the project, enabling it to be executed.

3.4.2 For externally funded projects, the requirements at various stages may be different and the agencies may ask for specific information involving various degree of accuracy of survey and investigations. The sequence of survey operations and project preparation may thus, have to be structured to meet the specific needs of the project, its funding option and the requirements of the authority sponsoring it. **Fig. 3.1** gives a Flow Chart of the Operations Involved in Highway Project Preparation.

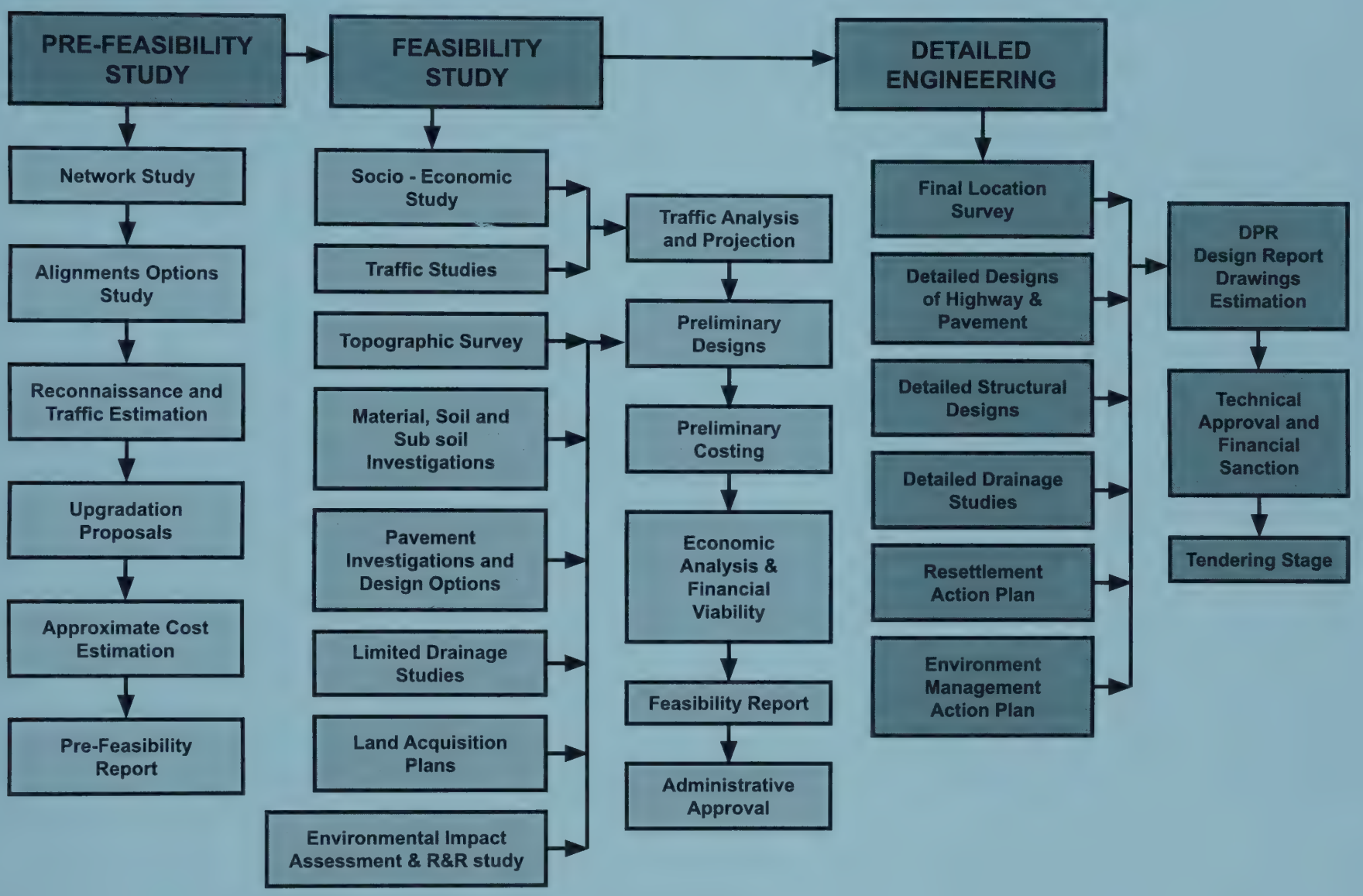


Fig. 3.1 Stages in Project Preparation

3.5 Project Clearances

3.5.1 The process of land acquisition needs to be started immediately after finalising the alignment. Provisions of the appropriate Land Acquisition Act will govern the various steps to be followed in the process of land acquisition. Depending on the quantum of land acquisition, creation of separate land acquisition authority is generally necessary. Acquisition of Government land, Private Land, Forest Land and land falling under Costal Regulation Zone, etc. will attract different acts/regulations.

3.5.2 The various steps in land acquisition, namely, appointment of exclusive Competent Authority (CALA), if required, declaring intention of acquisition, issuing notices and giving hearing

to the affected parties, joint measurements, final notices and acquisition of the land, etc. require considerable time and need to be closely monitored to acquire the land within the desired time limit.

3.5.3 Temporary and permanent structures coming in the alignment, trees need to be cut, including those in the forest lands, need special attention for obtaining permission/valuation from the Competent Authority. Similarly, obtaining permission of the Ministry of Forest and Environment for the forest land, Wildlife Clearance and the land coming in the coastal regulation zone need to be processed in time.

3.5.4 Detailed procedures for obtaining various project clearances are presented in **Section 18** of this manual.

4. GUIDING PRINCIPLES FOR ROUTE SELECTION AND ALIGNMENT IMPROVEMENT

4.1 The fundamental principle of route selection and alignment improvement is to achieve the least overall cost on transportation, having regard to the costs of initial construction of the highway facility, its maintenance, and road user cost, while at the same time, satisfying the social and environmental requirements.

4.2 Different possibilities exist for route selection and alignment improvement. There can be a totally green field alignment, or improvement of the existing road is done with bypasses and realignments. Green field alignment alternatives shall be prepared by using survey of India toposheets/Satellite Imageries/Digital Maps etc., duly considering various factors listed in **Appendix-1**. An illustrative example of arriving at the preferred alignment alternative is provided in **Appendix-8**, for guidance.

It should be understood that all these factors may not be applicable to each and every highway project and some of them, even if applicable, may not be feasible in many circumstances. For each case, the Client has to exercise judgement to reach an optimum solution, in the light of the fundamental principle of minimum transportation cost enunciated earlier.

4.3 Where the project involves improvements to an existing road, every effort should be directed towards removing the inherent deficiencies with respect to

a) Lane configuration and cross-sectional elements
b) Sight distance/visibility in horizontal as well as vertical plane
c) Cross-drainage structures
d) Road side drainage provisions as well as area drainage considerations
e) Safety features.

4.4 Any disregard of these aspects may lead to unnecessary expenditure, since at a later date the alignment may again have to be improved at considerable extra cost. It is, therefore, imperative that the final center line of the road with respect to which, the improvements are designed and to be carried out, is fixed with great care in view of ultimate geometric requirements and economy. The other important point is removal of structural deficiencies with an eye on future needs with respect to pavement, cross drainage and area drainage requirement etc.

4.5 Proper location and orientation of cross-drainage structures is an important factor

in the selection of the road alignment. Their importance increases with their length and cost. In general, for bridges having length between 60 and 300 m, location of the bridges as well as alignment of the approaches will have equal priority and should be well coordinated. For bridges of length more than 300 m, siting for the bridges will be primary guiding factor in route selection. For structures having length less than 60 m, highway alignment will guide the siting of the bridges.

4.6 Apart from engineering factors, environmental impact of the proposal should be fully kept in view in terms of such aspects as air pollution, damage to life systems, soil erosion, drainage pattern, landscaping, disruption of life of local communities, etc.

4.7 Comparison of overall cost shall be carried for various greenfield alignment options and improvement of the existing alignment and the alignment option involving minimum overall cost shall be selected.

Note: For assessing environmental impact of highway projects, reference may be made to **Section 9** of this Manual.

5. SURVEY OF SOCIO-ECONOMIC PROFILE

5.1 The economy of a region and its transport infrastructure are inter-related. The economic justification for a highway project often depends upon the economic activities in the region and potential for their further growth. The growth of traffic on the roads is likely to be governed by the inter-relationship between transport demand and certain selected economic indicators. Survey of the economic profile is, thus, an important component in project preparation.

5.2 The economic profile data are generally collected at two levels, viz., (a) Region or State and (b) Project Influence Area. The regional economic profile gives an idea of how the economic growth has taken place in relation to growth of traffic, thus, giving a basis for estimation of future growth of traffic for various scenarios of economic growth. The Project Influence Area is the zone in the near vicinity of the project highway, where development of the highway serves as a catalytic agent towards the speedy development of the area. Such a development generates additional traffic other than the normal. It may be sometimes necessary to collect data pertaining to other zones far from the region, if it has the potential to affect the traffic on the project corridor/ highway.

5.3 Survey of the socio-economic profile of the region should enable the presentation of an overview of the Region's/ State's economy, population and transport system over the past years and projected to future years. The data should be collected for at least past ten years.

5.4 The socio-economic status of the Road Influence Area should provide a descriptive and quantified profile from available data on population, agricultural production, area under crops, annual industrial and mining production by type of establishment, tourism potential and the inputs and outputs moving by road. Information on major planned development projects/ initiatives (type of establishment and expected annual production) should also be collected.

5.5 The historical data should be analyzed statistically to determine the growth trends and elasticity of traffic with respect to population, industrial production and agricultural produce. The planned rates of growth of those selected indicators viz., GDP, NSDP, Per Capita Income, Population in the future should also be obtained and used in the estimation of traffic.

6. TRAFFIC SURVEYS AND ANALYSIS

6.1 General

Information about traffic is indispensable for any highway project, since it would form the basis for the design of the pavement, fixing the number of traffic lanes, design of intersections and economic appraisal of the project, etc.

6.2 Network Study

It is important to study the road network in and outside the project influence area to understand the purpose of the project highway under consideration and its importance. The current traffic on the adjacent road network, the impact of improvement of the current project highway on the rest of the road network, the diversion of traffic from the existing network on account of the reduction in length and time of travel through the Project Highway, can be established by proper study of the road network.

Traffic surveys are required to be conducted/data to be collected in connection with the preparation of road project are as under:

a) Classified Traffic Volume Counts
b) Origin-Destination Surveys
c) Speed and Delay studies
d) Turning Movement Surveys at Intersections
e) Traffic Surveys for Replacing Railway Level Crossings with Over Bridges/ Subways
f) Axle Load Surveys
g) Accident Records
h) Pedestrian and Animal Cross Movement Count
i) Truck Terminal/Parking Surveys.

The purpose and method of surveys is presented in this **Section** and the formats for data collection are included in **Appendix-7**.

6.3 Classified Traffic Volume Counts

6.3.1 Classified Traffic Count is the basic study required in connection with many types of highway projects. A system of traffic census is in vogue in the country under which 7 days traffic counts are taken once or twice a year. The data from these can be judiciously made use of, if the census points fall on the proposed highway project. Nevertheless, it is always desirable to undertake fresh traffic surveys. Guidance may be taken from IRC:9 "Traffic Census on Non-Urban Roads." The count stations should be selected such that the results represent the traffic flow in homogeneous sections of the highway. The classified traffic volume count survey should be done preferably by using ATCC systems or Infrared Traffic Loggers or Videography or any equivalent later technology. In locations where there are site constraints, Traffic count may be done manually with specific approval from the Authority.

6.3.2 A seven days count will give the Average Daily Traffic (ADT). This value may be converted to Annual Average Daily Traffic (AADT) by applying seasonal factors and/or by using conversion factors from any continuous traffic count in the region.

6.3.3 When traffic census data from existing count stations are compiled, it may be found useful to collect past data (preferably about 10 years) so as to establish meaningful growth trends in the past for each vehicle class. Secondary data like fuel sales at nearest fuel stations may be considered if past traffic data is not available. Data pertaining to revenue collected at the Toll Plazas in the adjoining packages, or in the region may also be collected and judiciously used for estimation of past trends.

6.4 Origin-Destination (O-D) Surveys

6.4.1 When a new road is being planned, or extensive improvements are to be carried out to an existing road, or when a bypass is under consideration, the amount of traffic likely to use the highway cannot be ascertained from a simple census and it may become necessary to collect information about the origin and destination of the traffic passing through the area in which the road is situated. The origin and destination data should be comprehensive enough to cover all roads likely to be affected by the proposed scheme. The points at which the data is collected should be carefully chosen on the road network such that it should be possible to derive the volume of traffic likely to use the facility under consideration.

6.4.2 The survey should normally be conducted for three consecutive days, on sample basis, during a representative week in the year and must encompass the weekly market day and one working day. For exceptional cases, in heavy density corridors and where the daily variation in the traffic is not much, at least one day's survey may be conducted on a normal working day. Seasonal variation in traffic shall be kept in mind while interpreting the data.

6.4.3 There are several methods available for conducting the O-D survey. Information is available in IRC:102 'Traffic Studies for Planning Bypasses Around Towns". Generally, the "Roadside Interview Method (RSI)" and "Registration Plate Method (RPM)" are well-suited for roads in rural areas and can be conveniently adopted. RSI consists basically of interviewing drivers of vehicles at suitably located points with reference to the type of road scheme in consideration. At these stations, the number as well as the type of all vehicles passing the station are recorded. However, only a percentage of the drivers at random need to be stopped and interviewed for origin, destination and other travel particulars, like, commodity carried etc. The sampling should be systematic. Generally, 25 to 30 per cent of the vehicles may be covered in the peak periods, and 35 to 40 per cent in the normal periods. RPM consists of noting the registration numbers of vehicles. The sample size for Registration plate method shall be 60 to 80 percent in rural highways.

6.4.4 The sample should be upscaled to ADT and preferably hourly based classified vehicle type. The location of origin and destination zones will be determined in relation to each individual station and the possibility of traffic diversion to the project road from other road routes including bypasses. In principle, the zoning should bisect areas where competing roads pass and the zonal configuration shall be adequate on either side of the O-D station; thereafter, districts will serve as zones within the State. Zoning outside the State will relate to individual or groups of States in accordance with the distance from the O-D station. For coding purposes, code lists or code maps (to be shown to drivers) will be prepared giving zone number and towns within that zone. The updated (ADT) numbers shall then be presented by trip matrix. Information on weight of trucks should, following upscaling to ADT, be summed up by commodity type and the results tabulated, giving total weight and average weight per truck for various commodity types. Sample sizes for each vehicle type should also be indicated. A sample map of Zonal Division is indicated in **Fig. 6.1**.

6.4.5 After processing the O-D results, traffic is assigned from the trip matrix's elements to the project road's homogeneous sections, provided the route including the project road in its improved condition is the most desirable of the alternative routes available in terms of least vehicle operating costs.

6.5 Speed and Delay Studies

6.5.1 Highway improvements result in increased traffic and reduced congestion. Speed and delay studies on the existing facility provide the basis for estimating the causative problems and benefits of the improved facility.

6.5.2 The study is conveniently conducted by the "Moving Observer" method. By this method a test vehicle is run along with the traffic stream, at approximately the perceptible average speed of the traffic stream. A separate run is needed for each direction. The average of around six runs ensures accuracy of results. By noting down the travel time, including actual running time and stopped delays, the vehicles counted in the opposite direction and those overtaken/overtaking, it is possible to calculate the volume, speed and delay. For further information, IRC:102 "Traffic Studies for Planning Bypasses Round Towns" may be consulted.

6.6 Turning Movement Surveys at Intersections

6.6.1 Road intersection design requires information on directional movement of traffic in a day. The Intersection Turning Movement Counts are necessary to understand the traffic movements at intersections and also for design of intersections as per the local requirement. The intersection turning movement count survey should be carried out for successive 15 minutes period, for a minimum of 24 hours on a working day.

6.6.2 For simple 'T' or 4-way junction, the survey could be conducted by stationing enumerators on each arm of the junction to note the number of vehicles entering through the arm and the direction of their exit. At multi-legged junctions or rotaries, quick judgement about the exit direction or vehicles may not be possible. In such cases, a registration plate survey may have to be conducted. This consists of noting the registration numbers (generally only the last three digits) of a sample of vehicles entering the intersection.

6.6.3 Simultaneously, on each exit, the registration numbers of vehicles leaving the junction are noted. The two sets of numbers are then matched in the office to determine the directional movements. For recording traffic movement at a junction **Table 3.1**, Intersection Design Data given in IRC:SP:41 Guidelines for the design of At-Grade intersections in rural and urban areas shall be used.

6.6.4 Usually, it is not necessary to conduct traffic surveys on junctions where traffic on the minor cross road is less than 100 vehicles per day.

6.7 Traffic Surveys for Replacing Railway Level Crossings with Over Bridges/ Subways.

6.7.1 Present criteria of replacing railway level crossings with over bridges/underpasses are based on the product of gate closures and fast traffic per day. For this purpose, counts should be taken in a week spread over three consecutive days and 24 hours each day if such information

is not already available. The number and duration of gate closures should be ascertained from the Railway Authorities and also counted at site by conducting a 24 hours survey.

6.7.2 Information should also be obtained on the angle of crossing of the roadway and the railway. In case the road alignment has curves near the railway crossing, to make it a perpendicular crossing, an index plan including these curves and the straight alignment beyond, should also be included to study the feasibility of improving the road alignment as part of the project for replacing the level crossing.

6.7.3 As such, for safety considerations, all the level crossings on the State Highways and National Highways shall be replaced by an ROB or RUB. Continuation of Service roads across the railway line shall be decided in consultation with the Authority.

6.8 Axle Load Survey

6.8.1 Axle load survey is needed to generate data for pavement design. Portable weigh bridges are very useful for this purpose.

6.8.2 This survey shall be carried out along with classified volume count survey. Number of days of survey will depend on the project location, the type of project and the intensity and expected variation in traffic. This survey duration may vary between 24 hours and 3 days, but should be carried out at least for one day at the traffic count stations on a random basis for commercial vehicles. Buses may be omitted as their weight can be easily calculated and they do not result in excessive overloads.

6.8.3 The period of conducting the survey should also be judiciously selected keeping the movement of commodity/destination oriented dedicated type of commercial vehicles in view.

6.8.4 While finalizing the design by Equivalent Standard Axle Load (ESAL), the following should be considered:

a) Past axle load spectrum in the region as well as on the road to the extent available
b) Annual variation in commercial vehicles
c) Optimistic and pessimistic considerations of future generation of traffic
d) Generation of changing VDF factor during the project period

Portable weigh pads shall be calibrated before conducting the survey. Axle load data shall also be collected from nearest toll plaza or weigh bridge for validating the collected data.

6.9 Accident Records

If accident records are maintained in a methodical manner, they form a good basis for designing the improvements at accident-prone locations on existing roads. Such records, if available, should invariably be consulted before deciding the improvement measures.

6.10 Pedestrian/Animal Cross Traffic Surveys

The Pedestrian /Animal cross Counts are necessary to understand the movement of pedestrians/ cattle crossings at the built-up areas & intersection locations and also for providing the Pedestrian/ Animal cross facilities as per the local requirement. These shall be conducted to determine if

provision of underpass for pedestrians/animals is necessary to improve the traffic safety.

a) Pedestrian survey needs to be conducted when the alignment passes by such locations, (e.g., schools, hospitals, etc. on one side of alignment and the village on the other side), to decide the provision of appropriate crossing, such as, subway, Foot Over Bridge (FOB), Pedestrian Underpass (PUP)/(CUP).

b) Surveys for provision of pedestrian crossings shall also be conducted at all junctions being replaced by grade separators.

c) Information shall be collected from local consultations, and inputs shall be taken from local governmental/ non-governmental agencies in selecting sites for checking pedestrian/animal crossing traffic surveys.

6.11 Truck Terminal/Parking Surveys

Vehicle parking survey shall be conducted where the vehicles are parked along the project highway. Truck Lay Byes can be provided at such potential locations to avoid friction on the through traffic, and also due to safety considerations. Supplementary surveys shall be conducted to assess the requirement for development of truck terminals at suitable locations en route, for present and future traffic.

6.12 Traffic Projection

6.12.1 Traffic counts and O-D surveys would provide information about present traffic on the road (in the case of existing roads), or the possible diverted traffic (in the case of new construction, such as, bypasses). For design purpose, however, it is necessary that classified traffic should be predicted for the future horizon year for which the facility is to be designed.

6.12.2 Period of projection depends on the type of the project, importance of the road, availability of finances and other related factors. For major trunk routes, the desirable and minimum forecast periods are 15/20/30 years, (excluding the period of construction) though occasionally an even shorter period of 10 years is adopted depending on the policies of stage construction. In the case of lower category roads, the desirable period of projection is 10 years, but in no case should be less than 5 years. The Design Life shall be as stipulated in the manual of specifications and standards for different category of roads.

6.12.3 Traffic growth should be assessed in the first instance on the basis of observed trend of traffic in the recent years and other economic indicators using the technique given in **Appendix-2**. In this connection, the IRC:108 "Guidelines for Traffic Forecast on Highways", may be referred to. If reliable information is not available, as a broad guide, a compound growth rate of 5 per cent per annum could be adopted for this purpose.

6.12.4 Forecast of traffic based on past trends should also be modified for 'generated' traffic that may be using the highway facility after it is constructed. Generated traffic is quite distinct from the diverted traffic and represents journeys induced by reduced journey times and higher level of travel comfort which would not otherwise have been made. It is not necessary to allow for generated traffic on small schemes, but this may be called for on comparatively larger projects. Estimation of generated traffic should be carried out as per the guidelines given in IRC:108.

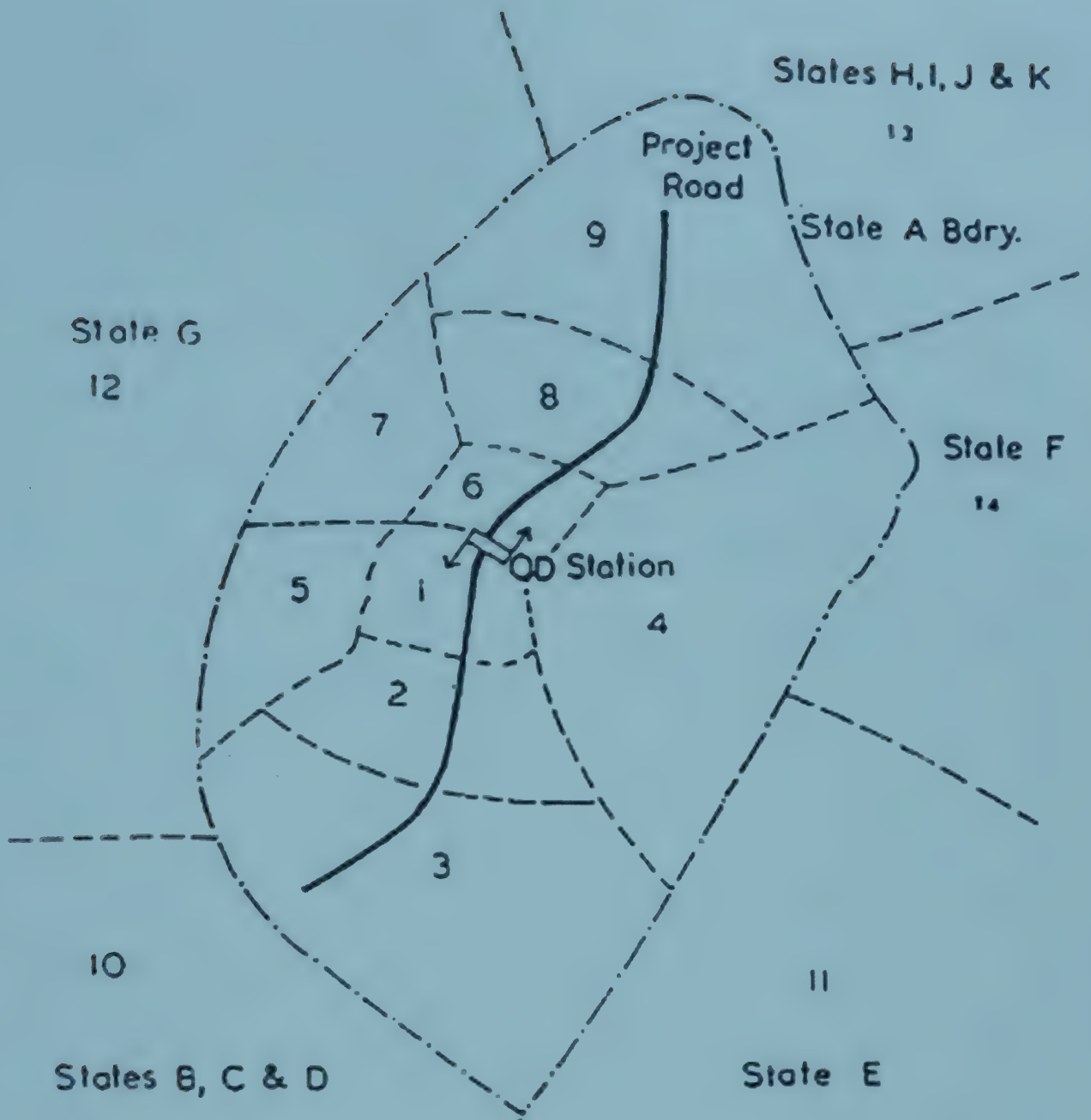


Fig. 6.1 Zonal Division (Sample)

7. RECONNAISSANCE SURVEY

7.1 Purpose

7.1.1 The main objective of reconnaissance survey is to examine the general character of the area for the purpose of determining the most feasible route, or routes, for detailed investigations. Data collected should be adequate to examine the feasibility of all the routes in question, and also to furnish the approximate estimates of quantities and costs, so as to enable the Client to decide on the most suitable alternative or alternatives. The survey should also help in determining any deviations necessary in the basic geometric standards to be adopted for the highway facility, on account of any constraints.

7.2 Survey Method

7.2.1 The reconnaissance survey may be conducted in the following sequence

a) Study of digital maps, topographical survey sheets, satellite imageries, aerial photographs, if available, and agricultural, soil, geological, meteorological maps etc., as required.

b) Aerial reconnaissance by Unmanned Aerial Vehicle (UAV) (for inaccessible and difficult stretches and wherever feasible),

c) Ground reconnaissance

7.3 Study of Digital Maps and Imageries

7.3.1 Reconnaissance begins with a study of all the available maps. The types of useful map information which are currently available in the country are as below:

a) Survey of India (SOI) Maps.

i) The most useful maps are the topographical sheets available in the scale of 1:25,000, 1:50,000 and 1:250,000. Maps with coverage on 1:50,000 and 1:250,000 scale are available for whole of India but map coverage with the preferable scale of 1:25,000 is at present, available only for a part of the country.

ii) State maps on scale 1:1,000,000.

These are useful as index maps or to indicate an overview of the project location and are available for most of the States.

b) Apart from the above-mentioned SOI maps there are special purpose maps, like, Forest Survey of India, Vegetation Maps on scale 1:25,000,000 showing incidence of orchards, reserve forests, clusters of social forestry areas etc., which may be helpful in selection of alignment in special cases.

c) Maps prepared by National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) indicating information on Soil, Wasteland etc., and Geological Survey of India Maps (on scale 1:50,000 or smaller) with information on geology, geomorphology and changes in drainage, river courses, etc. are available for many areas.

7.3.2 During the study of the topographical features on the maps, a number of feasible alignments are selected keeping the following points in view:

a) The alignment should take into account all the control/critical points and should be the shortest and most economical, compatible with the geometric requirements of gradient and curvature.

b) Avoidance, as far as possible, of marshy ground, steep terrain, unstable hill features and areas subject to severe climatic conditions, flooding and inundation.

c) Need of connecting important villages and towns.

d) Cross-drainage, canal crossings and area drainage

e) Need to preserve environment and maintain ecological balance.

f) Green field alignments, which generally reduce the distance between the origin and destination, should be studied based on the overall cost of widening the existing/green field alignment including the cost of construction, land acquisition, utility shifting, dismantling of structures, maintenance etc.

7.3.3 *Satellite remote sensing:*

Satellite imageries are available from National Remote Sensing Agency, Hyderabad on scales of 1: 12,500, 1:25,000 and 1:50,000. They are available in digital form so that the same can be integrated with other data through GIS interface.

Major advantage of satellite imagery is, it's repeatability, as orbiting satellites visit the same spot on earth every few weeks. Thus, the latest information regarding the physical features (like, the extent of a town or urban area, etc.) can be obtained to update on the available map. The information on natural resources namely, geology, geomorphology, land use, soil status (waterlogging, erosion, etc.), drainage, extent of forest, etc. as available may be most useful input for the planners of highway alignment.

7.3.4 *Digital Maps:*

Digital maps of the entire world are available on the web portal, for use of the planners. The maps are based on satellite imageries and photogrammetry.

7.4 Aerial Reconnaissance/Photogrammetry

7.4.1 Aerial reconnaissance provides a bird's eye view of the alignments under consideration along with the surrounding area. Aerial mobile LiDAR (Light Detection and Ranging) is a relatively new technology and is widely available for undertaking aerial reconnaissance surveys. However, aerial survey using UAV with Photogrammetry may be a better option, as LiDAR generates exhaustive point cloud data which may not be necessary at this stage. Aerial Photogrammetry using UAV requires establishment of ground control points, which gives rise to accurate data that can be used for preliminary design, costing and even preparation of land acquisition plans by superimposing on revenue maps. Final decision about the alignments to be studied in detail on the ground, could be taken on the basis of the aerial reconnaissance.

7.4.2 Tentative alignments shall be drawn on the selected maps, as convenient, and used for aerial and ground reconnaissance. In case of bypasses, a minimum of three alternatives shall be prepared. While preparing the alternatives, all the points listed in **Appendix-1** shall be considered. These alternatives shall be verified during ground reconnaissance for further improvement.

7.5 Ground Reconnaissance

7.5.1 Various alternative routes located as a result of the map study are further examined in the field by ground reconnaissance. As such, this part of the survey is an important link in the chain of activities leading to selection of the final route.

7.5.2 Reconnaissance consists of general examination of the ground by walking or riding along the probable route and collecting all available information necessary for evaluating the same. In the case of hill sections, it may sometime be advantageous to start the reconnaissance from the obligatory point situated close to the top. If an area is inaccessible for the purposes of ground reconnaissance, recourse may be had to aerial reconnaissance to clear the doubts.

7.5.3 While carrying out the ground reconnaissance, it is advisable to leave reference pegs to facilitate further survey operations. Handheld GPS and mobile phones are required in carrying out ground reconnaissance.

7.5.4 In difficult hilly and forest terrain, assistance of Global Positioning System (GPS) or Differential GPS (DGPS) may also be taken where the magnitude and importance of the work justify their use. GPS utilizes the satellites orbiting around the earth and a minimum of four satellites are needed to indicate the co-ordinates (X, Y, Z) on the ground at any time of day and night. The accuracy of observations depends on the type of equipment and the duration of observation. For more precise work DGPS can be used.

7.5.5 Points on which data may be collected during ground reconnaissance are listed in **Appendix-3**

7.6 Pre-feasibility Report

Based on the map study, information collected during the reconnaissance, traffic data from secondary sources, broad inventory and condition survey, preliminary upgradations proposals shall be drawn, cost estimates prepared, and viability established. A pre-feasibility report including all the relevant information collected during the survey, a plan to the scale of 1:50,000 or larger as available, showing the alternative alignments studied along with their general profile, rough cost estimates and preliminary viability, shall be prepared. It should discuss the merits and demerits of the different alternatives to help the selection of one or more alignments for detailed survey and investigation. For selection of most feasible option, quantitative approach may be followed as illustrated in **Appendix-8**.

8. TOPOGRAPHIC SURVEY

8.1 Purpose

8.1.1 Topographic survey is a relatively large-scale instrument survey conducted for the purpose of collecting all the physical information, which affects the proposed location of a new highway or improvements to an existing highway. In case of new roads, it consists of running an accurate traverse line along the route previously selected on the basis of the reconnaissance survey. In the case of existing roads where only improvements are proposed, the survey line is run along the existing alignment. During this phase of the survey, topographic features and other features, like, houses, monuments, places of worship, cremation or burial grounds, utility lines, existing road and railway lines, streams, rivers, canal crossings, cross-drainage structures, etc. are tied to the traverse line. Primary and secondary control points viz., GPS Pillars, Traverse Pillars and Bench Mark Pillars, are established for carrying out the detailed topographic survey. The data collected at this stage will form the basis for the determination of the final center line of the road. For this reason, it is essential that every precaution should be taken to maintain a high degree of accuracy. Use of advanced technology is explained in the later part of this section.

8.1.2 Besides the above, general information, which may be useful in fixing design features within close limits, is collected during this phase. In particular, information may be collected regarding:

a) The highest sub-soil and flood water levels, the variation between the maximum and minimum, and the nature and extent of inundation, if any, gathered from local enquires or other records. These should be correlated to data about the maximum and minimum rainfall and its duration, intensity, spacing, etc. by appropriate hydrological analysis.

b) The character of embankment foundations including the presence of any unstable strata likes micaceous schists, poor drainage or marshy areas; etc. This is particularly necessary in areas having deep cuts to achieve the grade.

c) Any particular construction problem of the area, like, sub-terranean flow, high level water storage resulting in steep hydraulic gradient across the alignment canal crossings and their closure periods. Information regarding earlier failure in the area of slides or settlements of slopes, embankments and foundations, together with causes thereto may also be gathered from records and enquiry where feasible.

d) In cut sections, the nature of rock i.e., hard, soft etc. should be determined by trial pits or boreholes. This is essential to make realistic cost estimates.

8.2 Survey Procedure

8.2.1 Topographic surveys, which are one of the most important and crucial field tasks under the project, should normally be taken up after the completion of reconnaissance surveys. Technologies that can meet the following accuracy levels shall be adopted.

For land-based and UAV-based surveys:

a) Fundamental horizontal accuracy of 5 cm or better

b) Fundamental vertical accuracy of 5 cm or better

c) More than 300 points shall be measured per sq. m and

For aerial based surveys using aircraft:

a) Fundamental horizontal accuracy of 5 cm or better

b) Fundamental vertical accuracy of 5 cm or better

c) More than 10 points shall be measured per sq. m.

8.2.2 For land-based surveys, Mobile LiDAR (Light Detection and Ranging) or better technology that can meet the above requirements shall be adopted. Laser used shall be Class 1 (eye safe), 905 nm, with a maximum resolution of 2 mm and scan rate of 700 k shots per sec. For UAV based surveys, Photogrammetry or Aerial Mobile LiDAR (Light Detection and Ranging) or better technology that can meet above requirements shall be adopted.

Where required, aerial LiDAR shall be supplemented with mobile/ terrestrial LiDAR and total station or better system to carry out detailed topographic surveys for the final alignment chosen. Aerial based surveys shall be used as the primary source of topographical data only in cases where a new/green field alignment is being planned and/or major junctions are being planned along the existing alignment, where it is necessary to significantly increase the survey corridor beyond the capabilities of mobile LiDAR.

For collecting data in shadow areas such as below culverts/bridges (for invert levels, soffit level/ HFL), terrestrial LiDAR/Total Station may be used. Where it is not feasible to use LiDAR or better technologies for any reason, especially for small Projects, the Client may decide to permit traditional methods of GPS/ Total Station/ Auto Level to carry out the study. Standard operating procedures for use of Mobile LiDAR, Aerial LiDAR, Aerial Photogrammetry are presented in **Appendix-13**.

8.2.3 Prior to start of the topographic survey, GPS Pillars/Traverse Pillars/Benchmark pillars shall be erected all along the selected route. The size of each precast pillar shall be 15 cm X

15 cm X 45 cm to be cast in RCC of grade M 15 with a nail fixed in the center of the top surface. The precast pillar shall be embedded in concrete up to a depth of 30cm with CC M10 (15 cm wide all around). The balance 15 cm of the pre-cast pillar above ground shall be painted yellow. The spacing shall be 250 m apart. Z value shall be transferred to these pillars from the nearest GTS Benchmark and the pillars shall be marked with RL and BM No. with red paint.

8.2.4 GPS Pillars shall be permanent in nature i.e. they should be useful during the construction (for falling back to reestablish the reference points), operation and maintenance, and beyond so that all the data collected by various equipment for different purposes can be tied to a single digital platform for future analysis and research. Hence, it is advisable that larger pillars of 1.5 m height with 30x30 cm on the top and 45x45 cm at the bottom are established. 50 cm of the pillar shall be above ground. These pillars can be part of a larger network of GPS Pillars, when such initiative is taken up by the ministry. Suitable notification may be made in gazette to allow fixation of such pillars in the project alignment.

8.2.5 After erecting the above survey monuments, survey shall be carried out to establish the primary control stations along the selected alignment at an interval of 2.5 km with Differential Global Positioning System (DGPS). A pair of observations to be made on control points for a duration of an hour using DGPS to observe the latitude and longitude. After completion of all the observations on control points along the entire alignment, they shall be converted to UTM Coordinate system based on WGS 84 Datum. These points should give Northing and Easting (X,Y Coordinates). Further, Accurate Level Control shall be established by carrying out the fly levelling on these pillars using auto level duly connecting the traverse to nearest GTS benchmarks established by Survey of India.

8.2.6 *The width of survey corridor will generally be as given under:*

a) The width of the survey corridor should take into account the layout of the proposed alignment, the extent of embankment, cut slopes and the general ground profile. While carrying out the field surveys, the widening scheme (i.e. right, left or symmetrical to the center line of the existing carriageway), the requirement of underpasses, slip roads, service roads, junction development in general, and near underpasses, intersections etc., should be taken into consideration so that the topographic surveys cover sufficient width beyond the center line of the proposed carriageway. Normally the surveys should extend a minimum of 30 m beyond either side of the center line of the proposed carriageway or the proposed right of way, whichever is more

b) In case the reconnaissance survey reveals the need for bypassing the congested locations, the traverse lines would be run along the possible alignments in order to identify and select the most suitable alignment for the bypass. The detailed topographic surveys should be carried out along the bypass alignment approved by Client. At locations where grade separated intersections could be the obvious choice, the survey area will be suitably increased. Field notes of the survey should be maintained which would also provide information about traffic, soil, drainage etc.

c) The width of the surveyed corridor will be widened appropriately where developments and/or encroachments have resulted in a requirement for adjustment in the alignment, or where it is felt that the existing alignment can be improved upon through minor adjustments.

d) Where existing roads cross the alignments, the survey will extend a minimum of 100-200 m either side of the road center line, depending on the cross slope of the terrain & the gradient of the cross road, and will be of sufficient width to allow improvements, including at grade intersection to be designed.

8.2.7 The detailed field surveys shall include all Physical features that are likely to affect the project proposals. Where the survey is for improving or upgrading an existing road, measurements should also be made for existing carriageway, roadway and location and radii of horizontal curves. In case of highways in rolling and hilly terrain the nature and extent of grades, ridges and valleys and vertical curves should necessarily be covered. As such this information can be extracted from the point cloud data produced by the LiDAR system or Photogrammetry.

8.2.8 When the detailed survey is required to be done with the help of Total Stations (with the specific approval of the Client) cross sections shall be taken at 25 m interval to cover the entire survey corridor including cross roads, future intersections, interchanges, flyovers, underpasses etc. In hilly terrain the cross sections can be at 10 m intervals. In both the cases, cross sections can be taken at closer intervals in sharp/steep curves, as required. In case of terrestrial/mobile/ aerial LiDAR, the equipment shall be capable of taking 300 points per sq. meter (or more) with which point cloud is generated and design is carried out. After carrying out the designs, cross sections can be automatically generated with utmost accuracy without any need for extrapolation. In case of the photogrammetry using UAV, care shall be taken to achieve atleast 70% of overlap in imaging.

8.2.9 Additional survey shall be done for the bridges and the other cross drainage structures as per relevant codes. Cross section of the streams, HFLs, invert levels etc. for the CD works shall be taken with supplementary surveys using Total Station and Auto Level. This will be integrated into the main survey data.

8.2.10 Field notes of the survey should be clear and concise, yet comprehensive enough for easy and accurate plotting.

8.2.11 In hilly areas, a 1.0 to 1.2 m wide trace cut may be made, if required, for future reference. For details in this regard, reference may be made to IRC:52 "Recommendations about the Alignment Survey and Geometric Design of Hill Roads".

Checklist on preliminary survey is available in **Appendix-4**.

9. ENVIRONMENTAL IMPACT ASSESSMENT & REHABILTATION AND RESETTLEMENT STUDY

9.1 General

9.1.1 The Environmental Impact Assessment (EIA) has become an integral part of highway project preparation work. The main purpose of EIA is to identify the environmental impact of the project proposal and its different alternatives, weigh their significance and severance, propose possible mitigating measures and provide necessary information for taking decision regarding the overall acceptability of the project from environmental angle.

9.1.2 The subject is being briefly described in the following paragraphs but in all cases of actual project preparation the provision in the "Guidelines for Environmental Impact Assessment

of Highway Projects" (IRC:104), Guidelines on Requirements for Environmental Clearance for Road Projects (IRC:SP:93) together with relevant circulars, notifications, guidelines and instructions issued by the Ministry of Environment, Forest and Climate Change (MOEF & CC) shall be followed as guiding principles.

9.1.3 *The EIA comprises mainly of the following four elements:*

a) Preliminary Screening and Environmental Analysis
b) Environmental Design
c) Compliance of Coastal Regulation Zonal requirements
d) Environmental Management Action Plan

In most of the cases the second element i.e. Environmental Design within its Scope will have a brief socio-economic base-line study, assessment of special requirements viz., Wild Life, Forests and Coastal Regulatory Zones and preparation of a Resettlement and Preliminary Rehabilitation Action Plan (RAP) may become necessary.

9.1.4 *Inter-alia the following legislations need due consideration:*

a) Environmental (Protection) Act, 1986
b) Wild life (Protection) Act 1972
c) Forest (Conservation) Act, 1980
d) Water (Prevention and Control of Pollution) Act, 1981 (Amended 1987)
e) Air (Prevention and Control of Pollution) Act ,1981 (Amended 1987)
f) Coastal Zone Regulation

Note: The latest versions/amendments shall be used.

9.1.5 The provisions in the Notification of the Government of India in Ministry of Environment and Forest and Climate Change No. S.O. 1533 dated 14.09.2006 and S.O. 2559 (E) dated 22.08.2013 shall be followed. As per the current provisions, Expansion of National Highways having length less than 100 km do not require Environmental Clearance irrespective of the width of land acquisition. Also, Expansion of National Highways having length more than 100 km but involving additional right of way or land acquisition not exceeding 40 m on existing alignments and 60 m on re-alignments or by-passes do not require Environment Clearance. However, obtaining environmental Clearance is mandatory for all new Green Field Highways irrespective of length. For State Highways, Environmental Clearance is required only for new State Highways and SH expansion projects in hilly terrain (above 1000 m AMSL) and or ecologically sensitive areas.

9.1.6 Salient features of MOEF&CC "Environmental Guidelines for Highway Projects" are covered in **Appendix-11**.

9.2 Environmental Analysis

A preliminary environmental/screening of the highway may be carried out to determine the magnitude of actual and potential impact and ensure that environmental considerations are given adequate weightage in the selection and design of the highway improvement/construction proposals. In **Appendix-5**, a chart for Initial Environment Examination (IEE) and suggested grading and protection measures have been indicated.

Positive and negative impacts of upgrading the highway or constructing a new highway shall be identified. Cost-effective measures may be proposed to enhance the positive impacts and to avoid or mitigate the effect of negative impacts.

Where felt necessary, public consultation with the affected groups or involved NGO's may be carried out.

9.3 Environmental Design

From the Environmental analysis, all elements with potential for adverse impacts should be identified, for which steps can then be taken to avoid/mitigate through judicious design changes (e.g., shifting the road alignment to save trees on one side of the road). Adverse impacts, such as, soil erosion, flooding, loss of vegetation cover, etc. should be identified and appropriate mitigating measures, like ground cover planting, installation of proper drainage system, etc. can be incorporated in design to reduce the impact. Cost effective proposals may also be included in the design proposal to suitably upgrade or enhance the environmental quality along the highway or the new alignment in a sustainable manner. Where possible, a few stretches along the project road may be selected for provision of facilities for non-motorized transport, which may provide an indirect encouragement to enhancement of environmental quality.

MoEF & CC directions stipulate the use of fly-ash in construction projects. The applicable guidelines regarding utilization of fly-ash shall be complied.

9.4 Environmental Management Action Plan

An implementation schedule and supervision programme may be prepared for timely execution of environmental mitigation and design works and all efforts may be made to stick to it. In important cases the programme for monitoring environmental impacts during construction and operation should be developed. For large projects, the requirement for institutional strengthening and training facility for personnel to be deployed on environmental works should be specified. Any further studies of environmental issues, which are required to be undertaken during project implementation should be recommended. The cost of implementation of Environment Management plan shall be added to the Total Project cost.

9.5 Resettlement and Rehabilitation Action Plan (RAP)

9.5.1 Whenever the project will entail acquisition of land, structures and other assets and cause displacement or loss of assets within the public right of way, the project should undertake a socio-economic base line study and prepare a Resettlement and Rehabilitation Action Plan (RAP).

9.5.2 *Broadly speaking, the RAP has three main objectives:*

a) To assess and bring out the impacts of land acquisition and assets for the project civil works on the people, who own properties in the area to be acquired or live on the land to be acquired and/or derive their income from the land or own enterprises operating on the land to be acquired,

b) To present the entitlement policy for compensation and assistance to people affected by the project, and

c) To prepare an action plan for delivery of compensation and assistance outlined in the policy to the persons duly identified as entitled to such assistance.

9.5.3 The present policy of the Government is that the population adversely affected by the project should receive benefits from it or at the least, they should not be worse off than before because of the project. Since acquisition of land and other assets may be unavoidable and is an integral part of project design and implementation, undertaking a social impact assessment and preparing RAP may also be included as a part of project design from the start and undertaken in close co-ordination with environmental analysis and environmental action plan. Also, as far as possible involuntary settlement may be avoided or at least minimized wherever possible, by exploring other alternative project designs.

9.5.4 The initial screening of social and environmental impacts should be a part of final selection of alignment. In this connection the initial Environmental Examination grading suggested in the table in **Appendix-5** may be seen.

9.5.5 In cases where displacement, loss of assets or other negative impacts on people are unavoidable, the project should assist the affected persons with means to improve their former living standards, income-earning capacities, production levels or at least maintain the previous standards of living.

9.5.6 Since no civil work can be undertaken on any stretch of road before land acquisition and payment of compensation as per RAP, it is essential that planning and implementation of civil works may be coordinated with RAP.

9.5.7 Preparation of RAP requires a thorough understanding of the local people, and the social, economic and cultural factors influencing their lives. It is essential that detailed base line studies are conducted with a participatory approach through consultation with potentially affected persons and other stake holders in the area, the local NGO's, municipal authorities, etc. and a mutually satisfactory solution is achieved.

10. FEASIBILITY REPORT

10.1 A Feasibility Report is prepared after the preliminary survey is completed. The report is intended to serve as the basis for according Administrative Approval (AA) for the project by the Highway Department/Public Works Department. When International funding is sought, it forms the basis for entering into negotiations with the funding agency and concluding an agreement for loan. The Feasibility Report must establish the economic viability and technical soundness of the alternative selected. Thus, it must be preceded by the engineering surveys and investigations of sufficient accuracy and detail so as to result in a fairly firm estimation of the cost of the project. It must be based on accurate traffic projections and must contain an economic analysis.

10.2 A full account of the socio-economic profile of the state and the Road Influence Area must be given in the Feasibility Report. The transport infrastructure of the state must be fully described, giving details of the road/transport sector. The Feasibility Report shall include discussion on different alternative alignments, alternative pavement design for deciding the one most suitable option as final option. Feasibility of stage construction should also be examined in the light of the rate of growth of traffic and other relevant parameters.

10.3 A brief outline of the organizational structure of the Authority must be given, establishing its adequacy in handling the project and giving details of any capacity augmentation/support system proposed.

10.4 The Report should give a brief description of the scope of the project, it's need, sources of funding, budget and plan provision, selection of route alignment, cross-sectional elements, drainage facilities and construction technology.

10.5 The methodology adopted for the various studies must be described. These include traffic surveys, soil, material and sub-soil investigations, hydrological and drainage studies.

10.6 The design standards and design methodology adopted must be explained.

10.7 The Report must contain a reasonably accurate estimate of costs, giving the basis for adopted rates. Any provision for escalation of costs must be explained.

10.8 The implementation programme involving prequalification, bidding, construction supervision and contract management must be drawn up and presented in the form of bar chart.

10.9 The economic analysis must be based on current costs. The IRC Manual on Economic Analysis of Highway Projects (Special Publication No. 30) gives details of the procedure that may be adopted. Some other models like HDM IV or its latest revision developed by the World Bank, RTEM III developed by Transport Research Laboratory U.K. after suitable calibration for Indian conditions also can be used, if so desired. A sensitivity analysis must be presented for the following cases:

a) Benefits minus 15 percent
b) Base costs plus 15 percent
c) Base benefits minus 15 percent and base costs plus 15 percent
d) Implementation delay: one year

10.10 In addition to catering for the uncertainties in the generated and diverted traffic, a sensitivity analysis shall be carried out considering the non-occurrence of the development envisaged and/or the diverted traffic not attracted as per assumption. For cost benefit assessment, the sensitivity analysis shall include:

a) Base Case
b) Pessimistic Scenario
c) Optimistic Scenario

10.11 The construction arrangements envisaged must be discussed. The procedure for prequalification of contractors and for bidding and supervision arrangements must be discussed. Generally, these shall be as per the extant policies of the Client.

10.12 In case of Build, Operate and Transfer (BOT) Projects, the financial analysis with different financial scenarios must be presented. The financial analysis may include cash flows, minimum construction time and exploring other revenues including the tolls.

10.13 The Feasibility Report must be accompanied by the following drawings:

a) Locality map
b) Plans showing various alternative alignments considered and the selected alignment

c) Typical cross-sections showing pavement details and widening scheme
d) Plan and Profile drawings
e) Drawings for cross-drainage and other structures
f) Road junction drawings
g) Strip plan showing the salient project features
h) Preliminary land acquisition plans

10.14 The Feasibility Study shall have the following broad coverage:

10.14.1 *Volume I-Main Report*

a) Executive summary
b) Regional/State socio-economic profile
c) Socio-economic profile of the project influence area
d) Methodology adopted for the studies
e) Traffic surveys and analysis
f) Engineering survey Investigations and Analysis
g) Project Road Description and or Improvement Proposals
h) Environmental Impact Assessment
i) Resettlement and Rehabilitation Action Plan
j) Project Cost Estimates including L.A. cost
k) Economic analysis including Sensitivity Analysis and Financial Analysis
l) Conclusions and Recommendations

10.14.2 *Volume II-Design Report*

a) Project Road Inventory
b) Engineering Survey and Investigation Data
c) Design Standards and Specifications
d) Pavement and Bridge Design

10.14.3 *Volume III-Drawings*

A check list for verification of contents of the Feasibility Report is given in **Appendix-6**.

11. STAKING FINAL ALIGNMENT ON GROUND

11.1 General

Upon receipt of approval of feasibility report from Client, the final alignment can be transferred to the field. It is necessary to stake the final center line on the ground for the purposes of carrying out the pre-construction activities including land acquisition, enumeration of utilities, trees, structures etc. After the publication of Notification for land acquisition i.e. publication of 3A in the Gazette as per NHA act, it is possible to erect the boundary pillars for the purpose of joint measurement survey for land acquisition.

11.2 Staking of Center Line

The final center line of the road should be suitably staked by fixing points at 50 m interval in plain and rolling terrain & 20 m interval in hilly terrain. The stakes are intended only for short period for carrying out enumeration and taking measurements of utilities, trees, buildings, religious structures and any other hindrances/ features. In the case of existing roads, paint marks with button headed steel nails may be used instead of stakes.

11.3 Boundary Pillars

Wherever the proposed alignment follows the existing alignment, the boundary pillars shall be fixed at an interval of 200 m on the extreme boundary of the proposed Right of Way, on either side. Wherever there is a proposal of realignment of the existing Highway and/or construction of new bypasses, boundary pillars shall be fixed at an interval of 50 m. Boundary pillars shall be strictly provided as per IRC:25-1967.

11.4 Proper Protection of Points of Reference

At the time of execution, all construction lines will be set out and checked with reference to the final center line established during the final location survey. It is important, therefore, that not only all the points referencing the center line should be protected and preserved but these are so fixed at site that there is little possibility of their being disturbed or removed till the construction is completed.

Among other things, field notes should give a clear description and location of all the bench marks and reference points. The information should be transferred to the plan & profile drawings so that at the time of construction, the bench marks could be located in the field without any difficulty.

A checklist indicating the major operations involved in the different types of survey and investigation for a road project is given in **Appendix-4**.

12. SOIL AND MATERIALS SURVEYS

12.1 General

12.1.1 Investigations for soil and other materials required for construction are carried out in respect of the likely sources and the availability and suitability of materials. Some other investigations, for instance in respect of landslide prone locations may also be conducted at this stage.

12.1.2 *Soil and materials surveys are required:*

i) to determine the nature and physical characteristics of soil and soil profile for design of embankment and pavement.

ii) to determine the salt content in soil in areas known to have problems, where the composition of the design crust requires such testing

iii) to determine the method(s) of handling soils

iv) to classify the earthwork involved, into various categories, such excavation in soft rock, hard rock, hard soil etc.

v) to gather general information regarding sub-soil water level and flooding; and

vi) to locate sources of borrow areas for embankment,

vii) quarries for fine aggregate and course aggregates required for pavement and structures and to ascertain their availability and suitability for use.

viii) locate sources of good quality water suitable for use in different items and work

12.2 Study of Available Information

12.2.1 The soil and materials location surveys should include study of all available information such as geological maps, data published by various authorities regarding location of construction materials and the information available with ground water authorities regarding depth of water table etc. Soil maps prepared by the local agricultural department and records of existing highways may also provide useful information. A study of these data, if available, will be of great help in the planning and conduct of further surveys and investigations. This information should be perused in conjunction with general information gathered during the preliminary survey (see **Para 8.1.2**).

12.2.2 After studying the available information, detailed programme of survey can be drawn up. Points needing attention during detailed soil survey are highlighted further.

12.3 Soil Investigations for Low Embankments

12.3.1 The first operation in the detailed soil survey is to demarcate the possible borrow areas. While demarcating borrow areas the directions contained in IRC:36 "Recommended Practice for Construction of Earth Embankments and Sub-Grade for Road Works " should be kept in view. The extent of borrow areas should be commensurate with the volume of work involved in the embankment.

12.3.2 The general character of material excavated from test pits should be recorded and tests conducted on it in the laboratory for properties mentioned. Where the type on material varies in a single pit, tests should be conducted on each type of soil separately and the horizon of occurrence is noted. Following tests should be carried out on material from cuts for the suitability of its use in the embankment shall be ascertained:

i) Gradation test (IS:2720 Part IV)

ii) Liquid limit and Plastic limit (IS:2720 Part V)/

iii) Density and Optimum Moisture Content (IS:2720 Part VII or Part VIII as relevant)

iv) Deleterious constituents (only in salt infested areas or where presence of salt is suspected) (IS:2720 Part XXVII)

However, in case of highly plastic, poorly draining and unstable soils, some additional soil tests for shrinkage properties may also need to be performed before accepting the same either for foundation or embankment/subgrade.

12.3.3 The results of the laboratory investigations should be summarized in a convenient form for which a proforma is suggested in **Table 12.1**. Usually this information should be enclosed in full, with the project report. Based on results of the tests, sand content, and classification of the soil in accordance with IS:1498 should also be determined. The final selection of the borrow areas, whether for the body of the embankment or the subgrade could then be made in accordance with the norms recommended in IRC:36 " Recommended Practice for Construction of Earth Embankments and Sub-Grade for Road Works" or MORTH Specifications. Great caution should be exercised to ensure and mark, as far as possible, homogenous soils only for this purpose. Heterogeneous or variable soils should be avoided. In making the selection, it should be ensured that the best available homogeneous, soil is reserved for use in the subgrade and top 500 mm portion of the embankment. After completing the analysis of the results, borrow area charts similar to the sample shown in **Fig. 12.1** should be prepared.

Table 12.1 Suggested Proforma for Presenting Laboratory Investigation Data of Soil for Embankment Construction

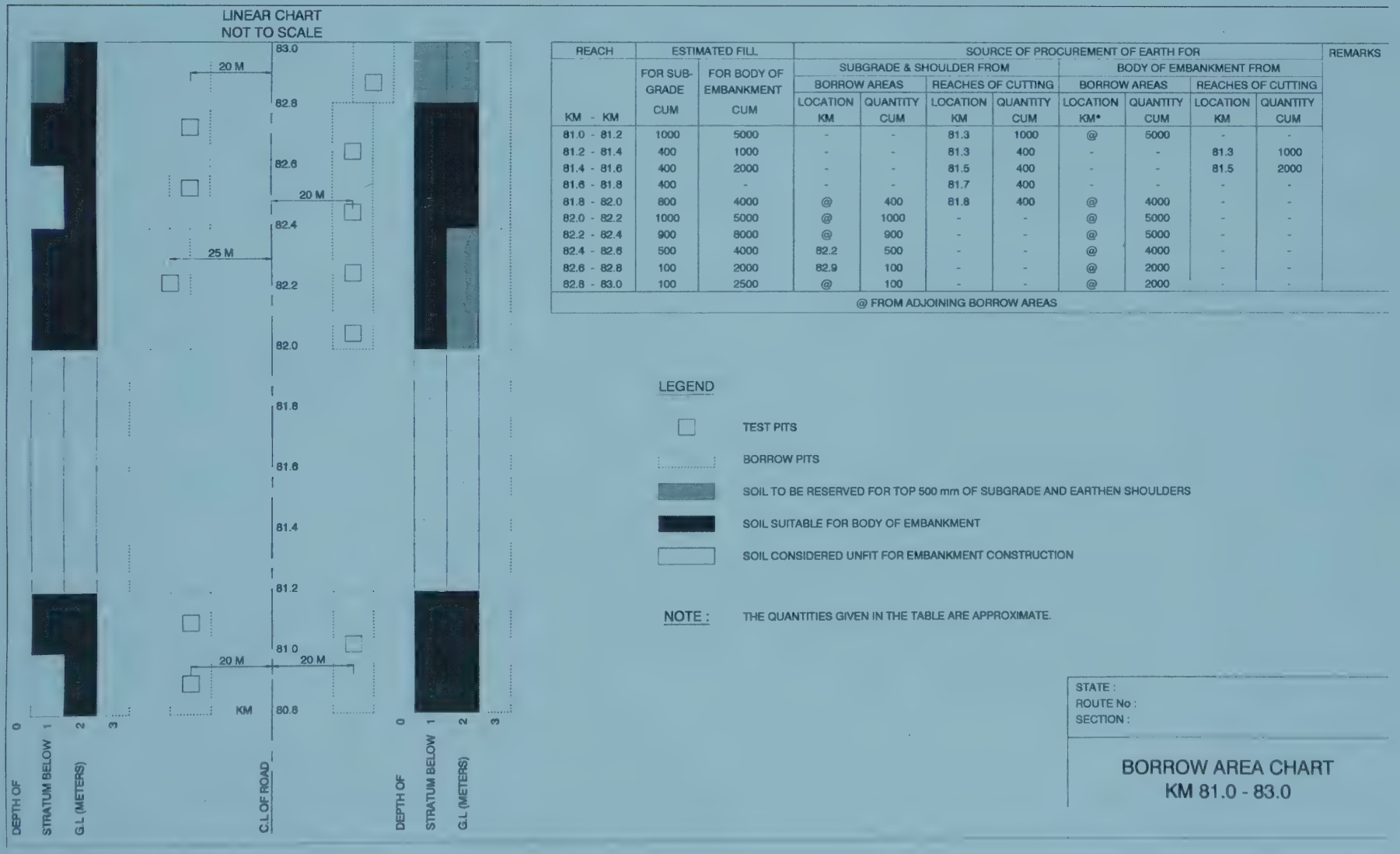
Name of the Laboratory/Institute .....

Name of the Technician .....

Date	Location	Type of Soil	Sieve analysis Percent Passing				Sand (percent) Content (Col.4) - (Col.7)
			4.7mm Sieve	2mm Sieve	425 micron Sieve	75 micron	
1	2	3	4	5	6	7	8

Atterberg limits (per cent)			Soil Classifi-cation	Density Test		Deleterious Constituents	Remarks
L.L.	P.L.	P.I		Max. Dry Density g/cc (Normal Heavy Compaction)	OMC per cent		
9	10	11	12	13	14	15	16

Note : If desired, the classification could alternatively be done according to the IS system of classification. See respective paras of IRC:36 'Recommended Practice for the Construction of Embankment and Sub-grade of Road Works' in this Regard.



REACH	ESTIMATED FILL		SOURCE OF PROCUREMENT OF EARTH FOR								REMARKS
			SUBGRADE & SHOULDER FROM				BODY OF EMBANKMENT FROM				
			BORROW AREAS		REACHES OF CUTTING		BORROW AREAS		REACHES OF CUTTING		
KM - KM	FOR SUB-GRADE CUM	FOR BODY OF EMBANKMENT CUM	LOCATION KM	QUANTITY CUM	LOCATION KM	QUANTITY CUM	LOCATION KM*	QUANTITY CUM	LOCATION KM	QUANTITY CUM	
81.0 - 81.2	1000	5000	-	-	81.3	1000	@	5000	-	-	
81.2 - 81.4	400	1000	-	-	81.3	400	-	-	81.3	1000	
81.4 - 81.6	400	2000	-	-	81.5	400	-	-	81.5	2000	
81.6 - 81.8	400	-	-	-	81.7	400	-	-	-	-	
81.8 - 82.0	800	4000	@	400	81.8	400	@	4000	-	-	
82.0 - 82.2	1000	5000	@	1000	-	-	@	5000	-	-	
82.2 - 82.4	900	8000	@	900	-	-	@	5000	-	-	
82.4 - 82.6	500	4000	82.2	500	-	-	@	4000	-	-	
82.6 - 82.8	100	2000	82.9	100	-	-	@	2000	-	-	
82.8 - 83.0	100	2500	@	100	-	-	@	2000	-	-	

@ FROM ADJOINING BORROW AREAS

LEGEND

- TEST PITS
- BORROW PITS
- SOIL TO BE RESERVED FOR TOP 500 mm OF SUBGRADE AND EARTHEN SHOULDERS
- SOIL SUITABLE FOR BODY OF EMBANKMENT
- SOIL CONSIDERED UNFIT FOR EMBANKMENT CONSTRUCTION

NOTE : THE QUANTITIES GIVEN IN THE TABLE ARE APPROXIMATE.

STATE :
ROUTE No :
SECTION :

BORROW AREA CHART
KM 81.0 - 83.0

Fig. 12.1 Borrow Area Chart

12.4 Special Investigations for High Embankments

12.4.1 The basic objective of investigations in case of high embankments is to obtain engineering data for soil and rock, necessary for a quantitative design of embankment at the chosen sites. Generally, for checking stability against slip failures, the basic properties to be investigated are shear parameters, unit weight and moisture conditions. For safety against excessive settlement, consolidation properties are important. For investigations in such cases, services of specialists may often be needed. Reference may also be made to IRC publication 'IRC:75 'Guidelines for the Design of High Embankments'.

12.4.2 In addition to the above, some special considerations required have been enumerated in **Appendix-1** to this manual for locating roads in hilly areas, desert areas, water-logged areas and areas subject to soil erosion. These points may be kept in view.

12.4.3 IRC Special Report No. 13 State of Art: High Embankment on Soft Ground Part-A- Stage Construction Contains recommendations for foundations for high Embankments. Special Report 14 entitled State of the Art High Embankments on Soft Ground- Part-B- Ground Improvement. The points mentioned in them would be of help in preparation of projects in similar situations. Software HED Version 1.0 (available with the IRC) for design of high embankment is recommended for analysis. This software can handle Slope stability analysis with seismic forces. This software has Graphic Capability.

List of laboratory tests to be conducted for highway embankment is placed as **Appendix-10**.

12.4.4 Ministry of Road Transport and Highways circular No. NH-VI-50(21)/79 dated 25th January, 1980 regarding "Investigation and Design for High Embankments at Approaches to Bridges and Over bridges on National Highways and other Centrally Financed Roads" has been printed with 17 Annexures in Addendum to Ministry's Technical Circulars and Directives on National Highways and Centrally Sponsored Road and Bridge Projects published by IRC. This circular is very exhaustive and covers basic steps and procedures for soil investigation, typical worked out example for stability analysis of embankments, filter design, settlement analysis, etc.

12.5 Soil Investigations for Cut Sections

12.5.1 In the same manner as described in **Para 12.4** for embankment material, soil in cut sections along the center line of the road at an elevation corresponding to the design subgrade level should be tested for the following general properties:

i) Gradation
ii) Atterberg limits
iii) Field density and moisture content
iv) Proctor density
v) California Bearing Ratio
vi) Shear strength parameters

12.5.2 In the case of rock cuts where necessary, trial pits or boreholes should be made to the foundation level, to make realistic estimates of the type of cutting involved. The interval of trial bores may be 30 to 50 m or as otherwise decided by the Engineer-In-Charge depending on specific requirements.

12.6 Special Investigations in Landslide-Prone Areas

12.6.1 Information collected during preliminary survey (see **Para 8.1.2**) would normally identify the landslide prone areas along the alignment and every effort would have been made to avoid these while fixing the center line of road. However, in case where the same is not feasible, further investigations would be required to study the extent of the problem and plan appropriate remedial measures. For this purpose, services of geologist or soil specialist may often be needed.

12.6.2 Depending on the geological configuration and drainage of the area, slides may take the form of rock or soil fall (i.e., movement of detached rock fragments at steep angles), rock flows (i.e., soil or rock mass suddenly losing strength and flowing like a liquid), or rotational slides (i.e., slips triggered under-cutting, erosion, external load on upper parts of the slope, or water seepage), investigation in each case will, therefore, depend on site conditions and the type of slide expected. These will involve collection of information about the existing slides, sources of water in the area, substrata profile, and other pertinent data which may facilitate inferences being drawn as to the cause, mechanism, and potentiality of slides.

12.6.3 For detailed guidance in regard to such investigation, reference might be made to standard publications on the subject and IRC Special Report No. 15 - "State of the Art: Landslide Correction Techniques".

12.7 Geo-technical Investigations and Sub-Soil Exploration

12.7.1 Geotechnical investigations shall be carried out to determine the sequence, extent and suitability of the soil and rock stratum to support the foundations of bridge or other structure and also to determine soil parameters and rock characteristics required for design of foundations by in-situ testing or laboratory testing of soil and rock samples collected from boreholes.

12.7.2 The geotechnical investigation shall be carried out in such a way that the profiles of different types of soil for the entire length of the proposed bridge or other structure is obtained and recorded.

12.7.3 Subsoil exploration shall consist of excavation, drilling of boreholes for the purpose of collection of undisturbed and disturbed samples, standard penetration tests, in situ vane shear tests and other field tests as specified by Engineer. Relevant Indian standards such as IS:1498, IS:1892, IS:2131, IS:2132, IS:4434, IS:4464 and Annex 2 of IRC:78 shall be followed.

12.7.4 The scheme of boring, indicating the proposed locations and the depth of boring, shall be submitted to Client for approval.

12.7.5 For the approach road pavement, bore holes at each major change in pavement condition or in deflection readings or at 2 km intervals whichever is less shall be carried out to a depth of at least 2 m below embankment base or to rock level and are to be fully logged.

12.8 Subgrade Characteristics and Strength

12.8.1 Based on the data derived from condition (surface condition, roughness) and structural strength surveys, the project road section should be divided into segments homogenous with respect to pavement condition and strength. The delineation of segments homogenous with respect to roughness and strength should be done using the cumulative difference approach (AASHTO).

12.8.2 *The testing scheme is, proposed as given under:*

a) · For the widening (2-Laning) of existing road within the ROW, at least three sub-grade soil samples shall be tested for each homogenous road segment or three samples for each soil type encountered, whichever is more.

b) For the roads along new alignments, the test pits for sub grade soil shall be @ 5 km interval or for each soil type, whichever is less. A minimum of three samples should be tested corresponding to each homogenous segment.

12.8.3 *The testing for subgrade soil shall include:*

a) in-situ density and moisture content at each test pit

b) Field CBR using DCP at each test pit

c) Characterization (grain size and Atterberg limits) at each test pit and,

d) Laboratory moisture-density characteristics (modified AASHTO compaction);

e) Laboratory CBR (unsoaked and 4-day soaked CBR on samples compacted at three energy levels) and swell.

12.9 Detailed Investigation for Flexible Pavement Design

12.9.1 New flexible pavements are to be designed in accordance with IRC:37 "Guidelines for the Design of Flexible Pavement". General principles laid down in this publication for moulding and testing soil specimens under different situations to use the CBR method of design should be kept in view.

12.9.2 For new roads, the soil data already collected in earlier phases of the survey should be studied in detail for ascertaining the variability/homogeneity of the soil profile and planning further investigations. Where pavement design relates to widening/strengthening of an existing road, the road should be divided into more or less identical sections on the basis of actual performance and pavement composition, as the basis for further testing.

12.9.3 For pavement design, apart from the general soil tests referred to earlier, CBR test should be conducted for soaked, unsoaked or both these conditions depending on the design requirement spelt out in IRC:37. Frequency of CBR testing may be decided based on the soil classification tests conducted at close interval of 500 m-1,000 m. Overall objective should be to get strength results for all changes in soil type or each demarcated section of similar performance.

12.9.4 A suggested proforma for presenting soil investigation data pertinent to flexible pavement design is given in **Table 12.2**.

12.9.5 Overlay design shall be done by Falling Weight Deflectometer (FWD) using IRC:115 Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements Using Falling Weight Deflectometer (FWD) Technique. Standard Operating Procedure for using FWD is presented in **Appendix 13**.

12.10 Detailed Investigation for Rigid Pavement Design

For design of cement concrete pavement in the case of new construction, 'K' value tests should be carried out with 75 cm diameter plate at the rate of generally, one test per km per lane unless foundation changes warrant additional tests. Further guidance in this respect can be had from IRC:58 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways".

For investigations in connection with the strengthening of existing rigid pavements, reference

may be made to the IRC:SP:17 "Guidelines for Concrete Overlays Concrete Pavements" and IRC:117 "Guidelines for the Structural Evaluation of Rigid Pavement using Falling Weight Deflectometer".

12.11 Naturally Occurring Aggregates for Pavement Courses

The survey for naturally occurring materials, like, stone aggregates, moorum, gravel, kankar, etc., to be employed in construction should embrace the identification of suitable quarries for these, the amount of material likely to be available from each, and the determination of physical and strength characteristics of the materials. The tests to be conducted and sample pro forma for presenting the test results are shown in **Tables 12.3** and **12.4**. **Table 12.3** is for aggregates, while **Table 12.4** is for naturally occurring materials like, moorum, gravel and soil-gravel/moorum mixtures. For every quarry source, at least three specimens should be tested for each type of material met with. Samples for the tests should be representative and collected in accordance with the procedure set forth in IS:2430. Quarry charts showing the location of quarries and the average lead of materials should also be prepared.

New road construction as well as essential maintenance and rehabilitation of existing network use substantial quantity of material resources, like earth, stone aggregate, binder, etc. On one hand material extraction, processing and production invariably have adverse impact on environmental and also leads to progressive depletion of existing resources. On the other hand, there are many heavy industries, like steel plants, power plants, etc. which produce a large quantity of waste materials, like slag, fly ash, bottom ash, etc. which pile up in the absence of satisfactory disposal constituting an environmental hazard. Road research has shown that these waste materials, like slag, fly ash, etc. can be gainfully utilised in various ways in construction of embankment, pavement, etc. which will not only be economical in certain areas but also will solve the disposal problem. Keeping in mind the environmental need and over-all economy in use of material resources, project preparation should aim at maximum utilization of these substitute materials in the construction process.

12.12 Manufactured Aggregates (Brick Aggregate)

Where the use of brick aggregates is envisaged, a survey should be made to identify the location and average lead from the work site of existing kilns capable of producing overburnt bricks/ brick bats. Where suitable kilns are not in operation, the survey should indicate the possibility of opening new kilns for the purpose.

12.13 Manufactured Sand

Manufactured sand could be utilised in construction where natural sand is not easily available subject to meeting the specifications stipulated.

12.14 Manufactured Items

For manufactured items, like lime, cement, steel and bitumen, information about their sources of supply and the distance of the nearest rail-head from the location of works should be gathered during the survey. For lime, in addition to source and lead, the information should cover its purity.

12.15 Water for Construction Purposes

Information should also be gathered about the availability of water near the work site and its suitability in conformity with IS:456 for construction purposes.

Table 12.2 Suggested Proforma for Recording Soil Investigation Data for Flexible Pavement Design

Average Annual Rainfall

State

Route

Section

Date of sampling	location		Nature of Soil (Visual identification)	Sieve analysis % by weight passing			Sand content (Col.5, Col7)	Attenberg Limits			Max. dry density gm/cc	OMC %	Field dry density at subgrade level for existing roads or new roads in cutting	**CBR of remoulded soil samples tested without soaking	**CBR of remoulded soil samples soaked in water for 4 days	Depth of water able below sub-grade under works condition (m)
	km	Cut/fill/ existing road		4.75mm sieve	4.25mm sieve	75 Micron sieve		Liquid Limit (LL) %	Plastic Limit (PL) %	Plasticity Index (PP)						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Note: **The moulding density (Whether Proctor density or field density) and the testing condition of samples (soaked or unsoaked) will depend on the nature of circumstances and design requirement. In some cases only unsoaked CBR values may be needed in others only soaked values, and in some, both unsoaked and soaked values. Both columns 15 & 16 do not therefore have to be filled in each and every case. For further guidance in this regard, references should be made to IRC:37 "Guidelines for the Design of Flexible Pavements"

Table 12.3 Suggested Proforma for Record of Test Value of Aggregates Like Stone Metal etc.,

State :

District :

Date of Testing :

Location and name of quarry if any (Correlated with index map)	Type of Rock (General group, classification or trade name)	specimen* No.	Los/Angeles** Abrasion Value (IS:2386-Part-IV)	Aggregate Impact Value**		Watch Absorption (IS:2386 Part-III)	Flakiness index ***(IS:2386 Part-I)		Surprising Value **** (IS:6241)	Remarks regarding performance of the aggregate wherever a systematic evaluation has been made	Addl. Remarks like old/ new quarry, approximate quantity available, existing access to quarry etc.,
				Dry test (IS:2386 Part-IV)	Wet test (IS:5640)		Nominal Size 40mm	Nominal Size 20mm			
1	2	3	4	5	6	7	8	9	10	11	12
Average											
Average											
Average											

Note : * For every quarry source, at least 3 specimens should be tested for each type of material met with

** For hard aggregates, like, stone metal, any one of the two tests given in Columns 4 & 5 may be conducted Wet test in Column 6 has to be done in th ecase of soft aggregates like laterite, kankar, brick metal etc.,

*** Not required to be carried out for soft aggregates, likes, laterite, kankar, brick metal etc.,

**** To be performed only when the material is to be used in bituminous constructions.

Table 12.4 Suggested Proforma for Record of Test Values of Naturally Occurring Soil-Gravel Moorum Mixtures

State

District

Date of Testing :

Location and name of quarry if any (correlated with index map)	General description of the material	Specimen No	Gradation : Per cent by weight passing the Sieve (IS:2720-Part-IV)							Atterberg limits (IS:2720-Part-V)			Proctor Test (IS:2720-Part-VII)			CBR Value***	Addl. Remarks, like new quarry, approximate quantity available, existing access to quarry, etc.,
			80 mm	40 mm	20 mm	10 mm	4.75 mm	2.36 mm	600 micron	75 micron	Liquid Limit (LL) %	Plastic Limit (PL) %	Plasticity Index (PI)	Density	OMC		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		1 2 3															
Average																	
Average																	
Average																	

Note : *** Tested in accordance with IS:2720 Part XVI on samples prepared at Proctor density, OMC and Soaked in water for 4 days.

13. ROAD INVENTORY AND CONDITION SURVEY

Many highway projects involve improvement to an existing road (strengthening/ widening) or construction of new facilities (bypasses), which are an improvement in traffic conditions over the existing facility. In all these cases, the scope of improvement measures and economic justification for them depends upon the condition of the existing road. It therefore, becomes necessary to prepare a road inventory and carryout condition survey.

Suggested formats are indicated in the **Appendix-7**.

In some Highway Departments/ Public Works Department, systematic data on roads and bridges is maintained and updated periodically. They are known as Road Registers and Bridge Registers. For national highways and many state highways there is an existing system of maintaining inventory. Wherever available, these data may be consulted and made use of.

The best way of preservation of collected data is to keep them in a computer-based road data bank. With the proliferation and increasing use of computers of different denominations in engineering works, this may soon become the usual method. With this expectation in view a brief note on introduction of computer-based road data bank is placed in **Appendix-12**.

In case the above sources are not available, a fresh road inventory shall have to be prepared. In any case, for preparation of DPR, the agency deployed for the purpose may have to carry out the inventory and condition survey to confirm the records being maintained by the Department and carry out the detailed designs.

13.1 Road and Pavement Investigations

Detailed field studies shall be carried out in respect of road and pavement. The data collected through road inventory and pavement investigations should be sufficient to meet the input requirements of HDM-IV.

13.2 Road Inventory Surveys

Detailed road inventory surveys shall be carried out to collect the following details of the existing road and pavement features.

a) Terrain (flat, rolling, mountainous);
b) Land-use (agricultural, commercial, forest, residential etc.) @ every kilometer;
c) Carriageway width, surfacing type @ every 500m and every change of feature whichever is earlier;
d) Shoulder surfacing type and width @ every 500m and every change of feature whichever is earlier;
e) Sub-grade/local soil type (textural classification) @ every 500m and every change of feature whichever is earlier;
f) Horizontal curves; vertical curves;
g) Road intersection type and details, at every occurrence;
h) Retaining structures and details, at every occurrence;
i) Location of water bodies (lakes and reservoirs), at every occurrence;

j) Height of embankment or depth of cut @ every 200m and every change of feature whichever is earlier.

k) Land width i.e. ROW from the boundary pillars & building lines

l) Culverts, (type, size, span arrangement and location)

m) Roadside arboriculture

n) Existing utility services on either side within ROW.

o) General drainage conditions

13.3 Pavement Investigation

a) Pavement Composition

i) The data concerning the pavement composition may be already available with the PWD. However, trial pits shall be made to ascertain the pavement composition. Alternately, Ground Penetration Radar of appropriate configuration may be deployed to identify the pavement layers by non-destructive means.

ii) If a test pit is made, the following information shall be recorded for each test pit:

- test pit reference (Identification number, location):
- pavement composition (material type and thickness); and
- subgrade type (textural classification) and condition (dry, wet)
- embankment (composition and geometry)

b) Road and Pavement Condition Surveys

Detailed field studies shall be carried out to collect road and pavement surface conditions. The data should generally cover:

- pavement condition (surface distress type and extent);
- shoulder condition;
- embankment condition; and
- drainage condition

i) Pavement Condition

- cracking (narrow and wide cracking), % of pavement area affected
- raveling, % of pavement area affected;
- potholing, % of pavement area affected; no. of pot holes, classified;
- edge break, length (m);
- rut depth, in mm

ii) Shoulder Condition

- Paved: Same as for pavement
- Unpaved: material loss, rut depth and corrugation,
- Edge drop, in mm.

iii) Embankment Condition

- general condition; and
- extent of slope erosion
- deficiency in design slope – flatter or steeper than the required

iv) Drainage Condition

- General condition
- Connectivity of drainage turnouts into the natural topography
- Condition in cut sections
- Condition at high embankments

The objective of the road and pavement condition surveys shall be to identify defects and sections with similar characteristics. All defects shall be systematically referenced, recorded and quantified for the purpose of determining the mode of rehabilitation.

i) In addition to visual means, the pavement condition surveys shall be carried out using Network Survey Vehicle (or equivalent) mounted with equipment such as high resolution cameras, digital laser profilometer, transverse profiler, the data from which should be geo-referenced using a DGPS receiver and in-vehicle data processing software, or equivalent technology to accurately measure the pavement surface properties covered earlier. This vehicle also takes the images of the assets to generate the road inventory. The Pavement Camera in the rear of the vehicle takes the pictures of the pavement showing the distress. The transverse profile logger (TPL) measures the rut depth and the camber of the pavement with the help of the lasers fitted on the TPL. Additional lasers provided in the wheel path measure roughness. The measurements made should be having an accuracy of at least 1.0 m.

ii) Supplemented by actual measurements and in accordance with the widely accepted methodology (AASHTO, IRC, OECD, TRL and World Bank Publications) adapted to meet the study requirements, the measurement of rut depth can also be made using standard straight edges, where NSV is not being used.

iii) The shoulder and embankment conditions shall be evaluated by visual means and the existence of distress modes (cuts, erosion marks, failure, drops) and extent (none, moderate, frequent and very frequent) of such distress manifestations would be recorded.

iv) For sections with severe distresses, additional investigations as appropriate shall be carried out to determine the cause of such distresses.

v) Middle 200m could be considered as representative sample for each one km. of road and incase all other things are considered similar.

The data obtained from the condition surveys should be analyzed and the road segments of more or less equal performance may be identified using the criteria given in IRC:81-1997.

c) Pavement Roughness

i) The roughness surveys shall be carried out using a network survey vehicle mounted laser profilometer or better technology. A standard operating procedure for using Net Work Survey Vehicle is presented in **Appendix-13**.

In addition, the following criteria should be met by the process of defect detection:

- Roughness measurement with outputs of both raw longitudinal profiles and IRI calculation shall be reported at 100m referenced to the preceding (Linear Reference Points) LRP. The roughness must meet ASTM-E950 (equivalent to Class I road profiler).

- The IRI shall be determined for both wheel-paths over a minimum length of 250m for a minimum of 6 calibration sites with a roughness range between 2m/km and 8m/km. Calibration shall be made for speeds of 20, 30, 40, 50, 60 km/h.

ii) The surveys shall be carried out along the outer wheel paths. The surveys shall cover a minimum of two runs along the wheel paths for each direction.

iii) The results of the survey shall be expressed in terms of BI and IRI, and shall be presented in tabular and graphical forms. The processed data shall be analyzed using the cumulative difference approach to identify road segments homogenous with respect to surface roughness.

14. DRAINAGE STUDIES

14.1 General

14.1.1 Drainage of highway refers to the satisfactory disposal of surplus water within the highway limits. The water involved may be precipitation falling on the road, surface run off form the adjacent land, seepage water moving through sub-terranean channels, or moisture rising by capillary action. Adequate information about drainage patterns is necessary to devise an effective drainage system, which brings into focus the need for requisite studies and investigations.

14.1.2 *Drainage studies have the following principal objectives:*

a) fixing the grade line of the road

b) design of pavement

c) design of the surface/sub-surface drainage system, and

d) design of cross drainage structures

14.1.3 Main components of the drainage investigation are determination of catchment area, HFL and ponded water level, depth of water table, range of tidal levels, where appropriate and the amount of surface runoff. Besides this, for cut sections in rolling and hilly areas, it would be necessary to carry out special investigations for sub-terranean flows and seepage of irrigation water from fields situated above the road.

14.1.4 Extent of studies and the data to be collected will depend on the type and scope of the project. Preliminary information could be collected through site inspection, single measurements and local enquiry. Most appropriate time for such enquiries is during the stage of preliminary survey (see **Section 8**) so that the information gathered can be of use in fixing the alignment and finalizing the broad strategy for improving the drainage. Detailed investigations could continue till the final location survey, when any adjustment in light of further data could still be made before the project is finally ready. In the case of cut sections, investigations for seepage and sub-terranean flows may generally have to be done again at the stage of formation cut, when new features may come to light warranting modifications in design or the need for special measures.

14.2 High Flood Level

14.2.1 HFL governs the road top level and the grade, and its reasonably precise estimation is particularly important. The design HFL should be based on a return period depending upon

the importance of the structure. Information in this regard can normally be had from the irrigation department, who maintains and analyzes such data. Inspection and local enquiry can often provide very useful information, such as marks left on guide bunds, river banks, trees or structures indicating the maximum flood level. HFLs so determined should also be compared with those for the adjoining sections of the road or nearby railway/irrigation embankments to correct any mistake.

14.2.2 Construction of a highway embankment may sometime block the natural drainage paths and cause heading up of water on upstream side. In finalizing the HFL, due allowance for the possible afflux in such circumstances must be made. Preferably, adequate number of openings shall be provided to avoid heading up of water on upstream side.

14.3 Depth of Water-Table

14.3.1 Knowledge of high water-table (for various return periods) is necessary for fixing the subgrade level deciding the thickness of pavement and taking other design measures such as provision of capillary cut-offs or interceptor drains. Depth of water-table may be measured in open wells along the alignment or in holes specially bored for the purpose. Usually, observations should be taken at intervals of one kilometre or less, preferably at the time of withdrawal of the monsoon, when the water-table is likely to be the highest. If there is any evidence of spring flow in the test holes, this should be carefully recorded. The depth of water table should be measured with reference to a common datum.

14.3.2 Besides high water table, it may be helpful to know the fluctuations in water-table. For this purpose, measurements of the lowest water-table in the driest month should also be made.

14.3.3 In areas, where the climate is arid and the water-table is known to be at least one metre below the general ground level, depth of water table need not be measured.

14.4 Ponded Water Level

In situation where water stagnates by the roadside for considerable period, e.g., irrigated fields etc., information about the level of standing water should also be collected and considered for design in conjunction with HFL and water-table.

14.5 Special Investigations for Cut-Sections

14.5.1 In cut sections in rolling or hilly terrain, the problem of seepage flows is common. The seepage water may be due to high water-table, sub-soil water moving through subterranean channels, where a permeable soil layer overlies an impermeable stratum, or irrigation water in adjoining fields situated at a higher level. Where such conditions exist, it may be necessary to intercept the seepage flow to prevent saturation of the pavement.

14.5.2 Preventive measures in this regard can consist of deep side drains of open or French type (to check sideway seepage or lower the water-table), buried transverse drains (to cut-off the longitudinal sub-surface flow, underneath the pavement, especially at the transition from cut to fill sections), or blanket course/sub-drains below the pavement in combination with side drains (to protect the pavement from excess hydraulic pressure). Actual treatment in each case will depend on factors such as the intensity of seepage, depth of the permeable strata etc., for which investigations would be required.

14.5.3 Analysis of water-table information (see Para 13) in conjunction with the surface profile will indicate the possible problematic areas with regard to seepage flows. As an adjunct to this, ground within the highway limits should be surveyed soon after the rainy season to visually identify the seepage zones, normally characterized by wet areas and patches. The following detailed investigations could then be taken up at these locations to decide the appropriate drainage measures against seepage:

a) Soil profile of the area i.e. soil type and the depth of various strata.

b) The head under which seepage water is flowing and its hydraulic gradient. This could be measured through a series of stand pipes placed in observation holes.

c) Permeability tests on strata through which the ground water is flowing.

14.5.4 It is desirable that investigations for seepage flows may have to be repeated during execution, particularly at the stage of formation cut, when it may be possible to make a closer examination to locate the seepage areas more accurately. The additional observations may warrant changes in the original design or the need for special measures.

14.6 Surface Run-off

14.6.1 Surface run-off to be catered for includes precipitation on the highway itself and flow from the adjoining areas. Run-off is ultimately led away from the highway area to the natural drainage channels by means of side drains. For the design of these drains, the following investigations, would be needed:

a) Study of ground contours of the land adjacent to the highway for determining the catchment contributing to the flow in side drains.

b) Determination of the surface characteristics of catchment area, i.e., the type of soil, vegetation, slopes etc., and

c) Study of ground contours for locating the outfall points.

In addition to the roadside drainage system special drainage provisions shall be designed for sections with super-elevated carriageways and high embankments. The drainage provisions shall also be worked out for road segments passing through urban areas.

14.6.2 For further guidance about the design of surface drainage system, reference may be made to the "IRC:SP:42 & IRC:SP:50".

Rain water harvesting requirements shall be assessed taking the Ministry of Environment & Forest Notification, into consideration. The construction of rainwater harvesting structure is mandatory in and around water scarce/crisis areas notified by the Central Ground Water Board.

15. CROSS-DRAINAGE STRUCTURES

For cross-drainage structures, i.e., culverts, surveys and investigations are carried out essentially for:

a) Selection of site, and

b) Collection of data for design of the structure.

Surveys and investigations, for bridges shall be conducted in accordance with IRC:SP:54 “Project Preparation Manual for Bridges”. Surveys and investigations, for culverts shall be conducted in

accordance with IRC:SP:13. The detailed designs of the structures shall be carried out as per relevant manuals and codes.

15.1 Selection of Site

By and large, the siting of culverts should be guided by the geometric features of the road alignment unless there are specific problems of location and design. Where defined channels exist for watercourses, the culverts may be located on them. In case of a flat and featureless terrain, culverts shall be provided for balancing purposes. The spacing and location may be decided by study of the catchment and allocation of the expected runoff among the culverts. Where there is a choice, the following points should be kept in view:

a) The site should be on a straight reach of the stream sufficiently below bends.

b) The location should be as far away from the confluence of the large tributaries as possible. So as to be beyond their disturbing influence.

c) The banks should be well defined.

d) As far as possible the site should enable a straight alignment and a square crossing.

15.2 Collection of Data for New Structures

15.2.1 For designing culverts, hydrological, physical and foundation data are required to be collected. In addition, site inspection with local enquiry and a study of the nearby road or railway cross-drainage structures on the same stream or in the vicinity, will provide useful information about HFL, afflux, tendency to scour, the probable maximum-discharge, the likelihood of collection of brush-wood during floods, foundation problems, etc.

15.2.2 *The essential data needed for design of new culverts are:*

a) **Catchment Area:** Where the catchment, as seen from the topographic sheet, is less than about 1.25 sq.km. in area, traverse should be made along the watershed. Where the area is flat without defined watershed, it would first be necessary to conduct a local contour survey to identify the watershed before taking up the traverse for larger catchments, the area can be measured from the 1:50,000 topographic maps.

b) **Cross-sections:** As a rule, for a sizeable stream, three cross-sections should be taken, one at the selected site, one upstream and another downstream of the site, all to the horizontal scale of not less than 1:1000 and exaggerated vertical scale of not less than 1:100. Approximate distance upstream and downstream of the selected site, where cross-sections may be taken as shown in **Table 15.1**.

Table 15.1 Location of Cross Sections for Streams

Catchment Area	Distance (U/S & D/S of the crossing) at which Crosss sections should be taken
2.5 Sq km	150 m
From 2.5 to 10 Sq km	300 m
Over 10 Sq km	400 to 1600 m

The cross-section at the proposed site of the crossing should show levels at close intervals and indicate outcrops of rock, formation of pools, scour holes etc. Where the existing road or a cart-track crosses the stream at the selected site,

the cross-section should not be taken along the center line of the road or the track as that will not represent the natural shape and size of the channel. Instead the cross-section should be taken at a short distance upstream or downstream.

In the case of very small streams (Catchments of 40 hectares or less), one cross-section may do but it should be carefully plotted so as to represent truly the normal size and shape of the channel on a straight reach.

c) **The Maximum HFL:** The maximum high flood level should be ascertained by intelligent local observation, supplemented by local enquiry and marked on the cross-sections.

d) **Longitudinal Section:** The longitudinal section should extend upstream and downstream of the proposed site up to the cross-section mentioned in (b) above and should show levels of the bed, low water level and the HFL.

e) **Velocity Observation:** Attempts should be made to observe the velocity during an actual flood, but if that flood is smaller than the maximum flood, the observed velocity should be suitably increased. The velocity thus obtained is a good check on the accuracy of velocity calculated theoretically.

f) **Trial Pits:** Where rock or some firm undisturbed soil stratum is not likely to be far below the bed of the stream, a trial pit should be dug up to the rock or firm soil. But if there is no rock or undisturbed firm soil close to the stream bed level, then the trial pit should be taken down roughly up to twice the maximum depth of the existing or anticipated scour line. The location of each trial pit should be shown in the cross-section of the proposed site. The trial pit section should be plotted to show the kind of soils passed through. Where trial pits are not possible because of longer depths or for other reasons, trial bores should instead be made. For very small culverts, one trial pit will be sufficient.

15.3 Design of Cross-drainage Structure

15.3.1 *The steps involved in the design of cross-drainage structures include:*

a) Estimation of design discharge
b) Choice of type of structure to be provided
c) Determination of waterway and vent height
d) Structural design of foundations, sub-structure and super-structure.

For details of the design procedure, reference may be made to IRC:SP:13 - "Guidelines for the Design of Small Bridges and Culverts".

15.4 Data where improvements are proposed to existing drainage structures

15.4.1 The existing drainage structures proposed for improvement should be surveyed and data collected on the following points:

a) Type of structure and details of span, vent height etc.
b) Existing width of roadway & water way
c) Condition of foundations (as applicable)/sub-structure, super-structure, parapets etc. and any deficiency to be rectified
d) Load carrying capacity of the structure, in case of bridges older than 30 years, or when the visual condition of the bridge suggests so.

e) Adequacy/inadequacy of waterway, signs of silting or blocking of the vent way, over topping of the structure, observed scour level, pattern, etc.

15.4.2 The data collected should be presented in a tabular form along with proposals for correcting deficiencies.

16. PREPARATION AND PRESENTATION OF DETAILED PROJECT REPORT (DPR)

16.1 General

The project data collected during the survey and investigation together with the proposal worked out on that basis should be presented in a proper form for full appreciation by the appropriate authority. These should be prepared in three parts under the following headings which when read together will constitute the complete project document:

a) The Report
b) Estimate
c) Drawings

Details to be presented in each part are brought out in subsequent paragraphs for guidance. It should, however, be understood that the extent of detailing of an individual aspect would depend upon the size of the concerned project and its scope, e.g., whether new construction or improvement to an existing road.

16.2 Project Report

The Project Report is one of the most important parts of the project document and should give a precise amount of the different features for easy understanding and appreciation of the proposals. The information provided may be conveniently dealt with under the following heads:

i) Executive Summary
ii) Introduction
iii) Socio-Economic Profile
iv) Traffic Surveys and Investigations,
v) Engineering Surveys and Investigations, and proposed road features
vi) Pavement Studies
vii) Design Standards and Specifications
viii) Drainage Facilities including Cross-Drainage Structures
ix) Environmental and Social Considerations including Rehabilitation and Resettlement
x) Materials, Labour and Equipment
xi) Rates and Cost Estimates
xii) Economic Analysis and Financial Analysis (where required)
xiv) Miscellaneous
xv) Conclusions and Recommendations

The design calculations, etc., with regard to the above items should be attached.

16.2.1 Executive Summary: Executive summary will summarise the entire report. All the salient points will be included. The executive summary should be such that a top executive is able to know all the features of the project that are required for decision making.

16.2.2 *Introduction: This should cover:*

a) **Name of the work and its broad scope:** Information here should give a general idea of the scheme as a whole.

b) **Authority and Plan Provision:** Give reference to the order of the competent authority calling for the project and the provision for the work in the relevant development plan.

c) **History, Geography, Climate, Demography, etc.,**

i) Previous history of the road and its present condition (in the case of existing roads) or development history for project as regards economic activity, population served, available transport facilities, etc. (in the case of a new roads).

ii) Highlight aspects such as prone to flooding of the area, waterlogging, etc.

iii) The general topographical and geological features of the area.

iv) Rainfall, annual average intensity and distribution during the year, range of temperature during summer and winter months periods of low and high water levels in river/canal, etc.

d) **Necessity:** Indicate the necessity for the project and the circumstances which have made its execution urgent.

16.2.3 Socio-economic profile: This should cover Socio-economic profile of the region and the Project influence Area (see **Section 5**)

16.2.4 Traffic Surveys and Traffic Forecasts: Discuss the type of traffic surveys conducted for various sections, the data collected and the results of future growth. Present the design traffic figures separately for each element of the project, e.g., width of carriageway, pavement, intersections, railway crossings, etc. For existing roads, discuss the accident data with special reference to the known accident- 'prone location.

16.2.5 Engineering Surveys and Investigations and Proposed Road Features: Description under this head should inter-alia cover:

a) **Route Selection**

Considerations governing the route selection and the effect of the proposed route on the overall transportation pattern of the area with respect to other facilities, like, railways, inland waterways, etc. (in the case of new roads). Discuss the merits and demerits of alternative routes investigated and reasons for selecting the proposed route.

b) **Alignment**

The general alignment of the road and its details, section by section, with reference to topographical and geological features, obligatory points, such as, bridge sites, important population centers, existing or prospective industrial centres, etc. Also, discuss points of general importance, like, high banks, heavy cuttings, nature of gradients, radii of curves, sight distance, nature of soil along that alignment, etc.

c) **Right of Way, Roadway, Carriageway and Other Cross-Section Elements**

Discuss the proposals regarding right-of-way, acquisition of structures alongside

roadway, carriageway width, etc. In the case of existing roads, compare the cross-sectional elements with the existing widths.

d) In case of the existing roads or where relevant, the above subject should cover aspects, such as, road inventory, road condition survey, geo-technical investigations, bridge inventory study, bridge condition survey, etc.

16.2.6 *Pavement studies*

a) **Road Design**

Bring out the special features of road design, e.g., fixation of grade line vis-a-vis HFL, water table, high embankments, treatment of cut sections, design of road junctions, removal of geometric deficiencies in the case of existing roads, remedial measures for land-side prone location, etc. Attach design calculations where necessary. Discuss any deviations from the prescribed standards, with reasons for the same.

b) **Pavement Design**

Present the soil investigation data for pavement design in a tabular form (including Benkelman Beam deflection data, if collected in the case of existing roads). Discuss the methodology of collecting these data and bring out the pavement design proposals with respect to the alternatives considered.

c) **Other works (other than CD. Works)**

Bring out the proposal for retaining walls, breast walls, pitching, parapet walls, railings, etc. Attach design calculation where required.

16.2.7 Designs Standards and Specifications: Give reference to the standard specifications, in accordance with which the works are proposed to be executed. Highlight where any modifications are proposed, or special specifications are advocated.

16.2.8 *Drainage facilities including cross-drainage structures*

a) Discuss the investigations carried out for designing the drainage measures and bring out the salient points in respect of H.F.L., water-table, ponded water level, seepage flows, closure periods in case of canals, etc.

b) Give details of the surface/sub-surface drainage measures proposed, e.g., longitudinal side drains, catch water drains, longitudinal transverse sub-drains, blanket courses, etc. Attach design calculations/drawings as necessary.

c) Highlight if any special measures are proposed to check soil erosion and assist soil conservation.

d) Discuss the proposal regarding small cross-drainage structures i.e., culverts. Give details of the proposed structures in a tabular form with cross reference to the standard designs adopted on the detailed drawings enclosed. The table should also indicate special features of each structures like design HFL, deck level, waterway, etc. Attach water-way calculations.

e) In case of improvement to existing roads list out the cross-drainage structures proposed to be improved/widened/reconstructed with details of improvement and justifications.

f) State whether the structures to be built with regard to standard designs. If so, give reference to the relevant drawings. Otherwise, attach design calculations and drawings.

16.2.9 Environmental and Social Consideration including R&R: Significant beneficial and detrimental impact of the proposed works on the environment in terms of air pollution, damage to life system, stream pollution, soil erosion, drainage pattern, landscaping, etc. Discuss the planning and design measures proposed to minimize/eliminate the adverse effects. Discuss also the resettlement and rehabilitation action plan.

16.3 Material, Labour and Equipment

a) **Materials**

Present the results of the soil and materials survey with reference to various sections of the road, bringing out clearly the sources from which the materials are to be obtained and their suitability of use in the works. Attach borrow material charts, quarry charts, results of tests on materials, etc. Discuss the facilities for transport of materials, and how these are to be provided.

b) **Labour**

Discuss the requirements of labour for the work, whether it is to be imported, skilled labour needed, housing facilities, etc.

c) **Equipment**

List the total equipment required for the implementation of the project. The list of equipment required to be maintained after construction, like, settlement gauge for high embankments.

16.4 Rates and Cost Estimates

a) Give reference to the Schedule of Rates adopted and the year of its publication. Indicate whether the schedule is current, or any corrections have to be applied. The schedule of rates must be realistic including the cost of machinery input, etc. to avoid revision of estimates.

b) Bring out the items for which suitable rates are not available in the schedule and for such items give reference to the analysis of rates attached to the estimate.

16.5 Economic and Financial Analysis (where required)

The DPR must contain the economic analysis carried out establishing the viability of the project. For details **Para 10.9** may be referred to. Where required, financial analysis may also be given.

16.6 Construction Programming

a) Mention whether the work is proposed to be executed departmentally or through contract, period proposed for completion of the project. Constraints, if any, which might possibly upset this schedule may be mentioned and plan to encounter them discussed.

b) Draw up a construction schedule, either in the form of a bar chart or on the basis of Critical Path Method (CPM). For details of the latter, reference may be made to IRC:SP:14.

c) Cash flow requirements for the proposed construction schedule should be mentioned.

16.7 Miscellaneous Items

a) **Wayside Amenities:** To increase the efficiency of work of truck drivers, for provision of better comfort and hygienic conditions at rest places to make essential items needed during travel, like, good food, first-aid, medical assistance, recreation, essential repair items for vehicles of both truckers as well as travelling passengers and tourists rest places with wayside amenities are required to be provided at suitable intervals. Complexes with wayside amenities for truck drivers, cleaners and other people attached to the carrier vehicles and also complexes with passenger oriented amenities are constructed for this purpose. These complexes also may provide at reasonable charges telephones, reading rooms, recreation and indoor sports rooms in addition to rest place, toilet, refueling and repair arrangements. The average distance between the complexes and their size and capacity will be determined by the intensity of the traffic flow along the highway.

b) **Parking Places:** Provision of adequate areas of parking spaces at suitable locations is an important feature of road networks, particularly in urban situations. On rural highways also, depending upon the intensity of traffic, parking places are required to be provided in complexes with wayside amenities for trucks as well as passenger cars and tourist vehicles. On busy roads when vehicle break-down occurs, the immobilised vehicle needs to be pulled upon the extreme edge of the road embankment so that it does not in any way interfere with the traffic flow. Near fuelling stations, rest or units with other type of amenities for travelers or truckers, there should be suitable lay-bys adjacent to the highway.

c) **Traffic and Traffic Safety:** The number of accidents occurring on our roads and the number of lives lost in road accidents is one of the highest in the world. Consequently, the total economic loss to the country is huge even excluding the cost of delay, pain, deprivation and suffering, etc. for which it is difficult to make economic evaluation. Pursuant to the national targets for reduction in accidents and fatalities, it is necessary to make provisions for traffic safety in the design and estimates of the project.

It is commonly said that traffic safety is dependent on provision of five E's, i.e.. Engineering, Enforcement, Education, Environment and Emergency. In the project preparation stage care can be taken only on the engineering aspect. Geometric and structural provisions in the project should, therefore, conform to the engineering standards and elements essential for the design speed, capacity, etc. of the concerned project. Since pedestrians and cyclists constitute a large percentage of the fatalities, specially on urban roads, adequate safety provisions, like, segregation, provision of side-walks, footpaths, cycle tracks, crossing facility at intersection, proper lighting, etc. where relevant, shall, have to be provided.

The MORT&H has published a " Manual for Safety in Road Design - A Guide for Highway Engineers", the suggestions of which should be kept in view during project preparation. Also, no compromise or comer-cutting shall be allowed on provision of adequate road signs, road marking and use of other suitable traffic safety aids.

d) **Safety Audit:** Depending upon the importance of the project, where considered necessary, arrangement for competent safety audit on the design and engineering provisions may be made for experts' advice by some eminent consultant or professional organisations.

e) **Toll Plazas:** For collection of toll fee for using a particular highway facility, it is often necessary to construct suitable toll plazas on the highways. The location of the Plaza should be decided consistent with the guidelines issued by Ministry of Road Transport and Highways from time to time, for planning, construction and operation of modern toll plazas on National Highways including procedural details for selection of an appropriate design, layout, construction keeping in view traffic, terrain and type of operating system desired (manual, semi-automatic, automatic), duly keeping the distance from the adjacent toll plazas on either side.

The plaza should be away from the municipal limits of the nearby towns, villages, structures etc. and preferably lie in a straight alignment. The location should be such that the cost of acquisition of land, structures etc. is minimum. It should in general not lie in bypasses and locations, where traffic may evade the plaza and ply through alternate routes.

f) **Dumping Grounds:** One of the essential requirement of road planning and design is to make proper provision for utilisation of unwanted surplus materials resulting from construction excavations in earth work and rock, etc. are normally tried to be adjusted between cut and fill sections or utilisation low level areas within reasonable leads. Where no such thing is possible or if the surplus material is of unwanted nature (like, dismantled old road crust, elements of dismantled structures, stumps and root system for trees, rejected bituminous mixes, etc.) these require to be dumped in specially earmarked places. Depending upon the requirement of space suitable fallow land or naturally depressed low lands in need of filling may be identified within easy and economic leads for dumping of such materials. The project estimate may make suitable provisions for such arrangement.

The DPR may contain an assessment of the requirement of various miscellaneous items, their type design and suitability of location, etc., like the following:

i) Bus bay and shelters
ii) Truck lay byes/parking areas
iii) Tourist facility items, such as, rest areas/way side amenities, parking/ scenic lay-bys;
iv) Traffic control/safety devices and road furniture viz., traffic signs, pavement marking, guard stones, kilo meter stones, delineators, crash barriers etc.
v) Pavement, slopes and road side drainage
vi) Median plantation, Avenue plantation, turfing, landscaping etc.
vii) Toll plazas and Toll Management Systems
viii) Advanced Traffic Management System (ATMS).
ix) Incident Management Systems
x) Traffic Management and Safety in construction zone;
xi) Construction Camps; Temporary Diversions and Haul Roads;
xii) Arrangement for water supply and other site amenities;

g) **Conclusions and Recommendations:** This should cover conclusions and recommendations about the project as a summary.

16.8 Estimate

16.8.1 The project estimate should give a clear picture of the financial commitment involved and should be realistic. This is possible only if the items of work are carefully listed, the quantities determined to a reasonable degree of accuracy, and the rates provided on a realistic basis.

16.8.2 *The estimate should consist of;*

a) **General abstract of cost:** This should give the total cost of the scheme with a general break-up under major heads (with further sub-divisions as necessary), e.g., site clearance, earthwork, sub-bases and bases, bituminous work/cement concrete pavement; cross- drainage and other miscellaneous structures; miscellaneous items, percentage charges for contingencies, escalation, quality control, etc. The General Abstract of cost should also include the cost of land acquisition, shifting utilities, like, electric lines, telephone poles, underground cables, gas lines, sewers, water pipes, cost of arboriculture, cost of removal of trees and compensatory afforestation.

b) **Detailed estimates for each major head:** These should consist of

   i) abstract of cost

   ii) estimate of quantities

   iii) analysis of rates for items not covered by the relevant schedule of rates; and

   iv) quarry/material source charts

16.9 Drawings

16.9.1 *General:*

Project drawings should depict the proposed works in relation to the existing features, besides other information necessary for easy and accurate translation of the proposals in the fields. For easy understanding and interpretation, it is desirable that the drawings should follow a uniform practice with regard to size, scales, and the details to be incorporated.

16.9.2 *Drawing size:*

Drawings should be adequate size to accommodate a reasonable length of the road or a structural unit in full details. At the same time, these should not be inconveniently large to necessitate several folds. From this angle, it is recommended that preferably the size may be 594x420 mm or 420x297 mm corresponding to A2, A3 respectively, as per IS:696-1960. Drawings of this size could be stitched in a folder with flexible covers so that the folio can be rolled for convenient handling. On sheet of A2 size, it will be possible to accommodate the plan and L-section of one km length of the road, with sufficient overlap on either side and on sheet of A3 size, it will be possible to accommodate the plan and L-section of 1000 m length of the road, with sufficient overlap on either side, if drawn to the horizontal scale of 1:2500. A wider margin of 40 mm may be kept on the left hand side of the drawing to facilitate stitching into a folio.

16.9.3 *Component parts of highway project drawings:*

The drawings usually required for a road project include the following:

Locality map-cum-site plan: This is combination of a key map and index map drawn on a single sheet. This will be the first sheet in folio of drawings for a particular section of the road. However,

where the length of a section is substantial, it may become necessary to separate out the locality map and the site plan. The former being accommodated in one sheet and the latter on a series of sheets.

The locality map (same as key map) should show the location of the road with respect to important towns and industrial centres and the existing means of communication' in the neighbourhood so as to give a bird's eyeview of the proposed work. The map may be to a scale of 1 :250,000 which is one of the common scales used in Survey of India maps.

The site plan (same as index map) should show the project road and its immediate neighbourhood covering the important physical features, such as, hills, rivers, tanks, railway lines, etc. It may be to a scale of 1 :50,000 and should show the, kilometres from the beginning to end.

The sheet containing the locality map-cum-site plan should have a legend to explain the abbreviations and symbols used in subsequent drawing sheets.

One typical example of location map-cum-site plan may be seen in **Plate-1**.

a) **Land Acquisition Plans:** These should be prepared on existing village maps or settlement maps giving the details of property boundaries and their survey numbers. A scale in the range of 1 :2000 to 1 :8000 depending on available maps will be suitable. If for any reason detailed land acquisition plans are not possible, rough plans should be prepared. Inter alia, the plans should show the final centreline of the road; and right-of-way boundaries, buildings, wells, monuments, trees, etc. affected by the road alignment, type of land, i.e., irrigated, wet, dry, barren, forest, etc. and the nature of crops. For detailed procedure of Land Acquisition and preparation of Land Plans reference may be made to **Section 18**.

b) **Plan and longitudinal section:** Plan and longitudinal section for one km length of the road should be shown on a single drawing sheet as far as possible the plan should be at the top and the longitudinal section at the bottom. Common scale adopted is 1:2500 for the horizontal, and 1 :250 for the vertical, but this may be changed suitably for hilly stretches.

   The plan, among other things, should show the final centreline of the road, right-of-way limits, roadway of the existing road where applicable, existing structures, drainage, courses, intersecting roads, railway lines, electric and telephone lines, cables, location of cross drainage structures, design details of horizontal curves, bench marks, location of cross sections, contours, north point, etc.

   The longitudinal section should show the profiles of the proposed road, the general ground, and the existing road where applicable. In addition, it should show details, such as, the gradients, location and set out data for vertical curves, super-elevation, details of horizontal alignment, the design HFL, location of drainage crossings and intersecting roads, pavement design features, continuous chainage, etc.

   The manner of presenting the details on the plan and longitudinal section drawings is illustrated in **Plate-2**.

c) **Typical cross-section sheet:** In a highway project, cross-section elements, like, width of the carriageway and roadway, side slopes, and pavements cross fall will generally remain constant for most of the road length. Instead of repeating these details on every cross-section, it would be desirable to show these on a typical cross-section sheet. The number of typical cross-sections to be drawn

will depend on the type of project, the terrain traversed, etc.. For Typical cross sections of different configurations (2/4/6/ lane and expressway), the applicable manuals may be referred.

These should be drawn to a scale of 1:100.

d) **Detailed cross-sections:** A few detailed cross-sections may be presented serially along the continuous chainage. These should show the ground levels, existing road levels where applicable, and the proposed road levels. The area of cut and/or fill involved should be indicated as also the type and thickness of the different pavement courses. For rest of the cross-sections computer charts showing tabulated level details and distances may be appended.

The recommended manner of presenting the cross-sections is illustrated in **Plate-3**. A typical scheme of providing offsets in the pavement layers is presented in **Plate-4**.

e) **Drawings for structures:** In a highway project, a large number of structures, (i.e., culverts, Bridges, Underpasses etc.,) will be required to be constructed. A separate drawing should be prepared for each structure with a scale of 1:50.

16.10 Check List

Appendix-4 gives a check list for the various surveys and investigation work involved in the preparation of a road project. The various items that should be incorporated in a detailed Project Report are shown in the form of a check list in **Appendix-9** for guidance. This is intended to serve in a ready reference to ensure that all the items have been included and give an opportunity to the engineer preparing the project to review his work and if necessary to state in the reports why some items have been left out.

17. ECONOMIC & FINANCIAL ANALYSIS

17.1 Economic Analysis

The benefit and cost streams should be worked out for the project using HDM-IV or other internationally recognized life-cycle costing model, for each of the project sections identified.

Economic analysis shall cover the following aspects:

i) Assessment of the capacity of existing roads and the effects of capacity constraints on Vehicle Operating Costs (VOC);

ii) Calculation of VOCs for the existing road situation and those for the project;

iii) Quantification of all economic benefits, including those from reduced congestion, travel distance, savings in road maintenance cost and reduced incidence of road accidents; and,

iv) Estimation of the Economic Internal Rate of Return (EIRR) for the project over a 30-year period. In calculating the EIRRs, identify the tradable and non-tradable components of projects costs and the border price value of the tradable components.

v) Assessment of Saving in time value.

Economic Internal Rate of Return (EIRR) and Net Present Value (NPV), “with “and “without time and accident savings” should be worked out based on these cost-benefit streams. Furthermore, sensitivity of EIRR and NPV shall be worked out for different scenarios as given under:

Scenario I	Base Costs and Base Benefits
Scenario II	Base Costs + 15%, and Base Benefits
Scenario III	Base Costs, and Base Benefits – 15%
Scenario IV	Base Costs + 15%, and Base Benefits – 15%

The sensitivity scenarios given above are only indicative. More scenarios can be selected taking into account possible construction delays, construction costs overrun, traffic volume, revenue shortfalls, operating costs, exchange rate variations, convertibility of foreign exchange, interest rate volatility, non-compliance or default by contractors, political risks and force majeure.

The economic analysis shall also take into account all on-going and future road and transport infrastructure projects and future development plans in the project area.

17.2 Financial Analysis

The objective and methodology of Financial Analysis is described hereinafter.

The main objective of financial analysis is to find the likely returns to the investor. This covers aspects like financing through debt and equity, loan repayment, debt servicing, taxation, depreciation etc. The viability of the project shall be evaluated on the basis of cash flow analysis, where both costs and revenue have been indexed to take in to account of the inflation.

Financial viability analysis shall be done on the basis of a financial model developed by the agency. The model projects the key financial statements of the investor over the concession period. Concession period of 10/15/20/25/30 years shall be considered and the growth rate of the traffic may be assumed at minimum of 5% per annum. All investment costs and capital expenses will be identified in the year in which they are deemed to occur. Suitable inflation rate will be applied to all cost and revenue items.

The construction is to be financed through both equity and loan. A Debt-Equity ratio of 70:30 would be appropriate as most financial institutions hesitate to lend at higher leverages and also in view of the fact that a high gearing invariably subjects projects to substantial financial risks. A 15-year period is proposed for construction loan repayment. The rate of interest considered shall be in line with the prevailing lending rates of financial institutions. The actual financial parameters to be adopted in the analysis will be reviewed after gathering additional data from published sources and finalised in consultation with the Authority as per the TOR.

Depreciation of capital items will be calculated by using two methods, viz. the Written down Value (WDV) Method and the Straight Line Method (SLM). The WDV method favors income shielding and is, therefore, used only to calculate taxes payable by the concessionaire. The rate permitted for a toll road enterprise, viz. 10 percent will be used in the analysis.

Tax holiday (100% tax exemption on profits and gains), as per Section 80-IA of Income Tax Act, shall be available from such business for 10 consecutive assessment years out of 20 years beginning with the year in which undertaking or the enterprise develops and begins to operate any infrastructure facility or develops an industrial park or special economic zone or generates power or commences transmission or distribution of power or undertakes substantial renovation or modernization. The corporate tax rate adopted will be based on the latest Finance Bill.

The NPV and FIRR for the project shall be calculated. It shall undertake sensitivity analysis by identifying the most critical factors and determine their impact on FIRR, including varying project

costs and benefits, implementation period, and combination of these factors. Risk analysis will be conducted by considering the possible values for key variables based on records and their occurrence probability.

18. PRE-CONSTRUCTION ACTIVITIES & PROJECT CLEARANCES

18.1 General

Besides preparation of the Project Report, it is equally important to procure the clearances required for implementation of the Project viz. environmental clearance, wild life clearance, CRZ clearance, clearance for ROBs/RUBs, cross drainage structures/bridges over canals, Underpasses over cross roads etc. from various statutory bodies, Railways, Irrigation Department, R&B Department, Electrical Department, RWS Department and so on. Handing over of vacant access to Site being the primary task, Land Acquisition, removal of encumbrances/encroachments/Structures/ Utilities and other hindrances assumes top priority. A brief procedure for each Preconstruction Activity, the requirements and the methodology for obtaining various clearances is presented in the following section.

18.2 Environment and Social Impact Assessment

For Environmental and Social Impact Assessment, reference may be made to **Section 9**.

18.3 Land Acquisition Process

The process of land acquisition for upgrading National Highways is done in accordance with the procedure laid in the National Highways Act, 1956. The Act provides broad guidelines for land acquisition. The NH Act is commonly used for acquisition of land for any public purpose, more specifically for the projects being funded by the MORTH. The current section explains the LA procedure to be followed for acquisition of land as per NH Act and if any executing agency bears the cost of land acquisition, and hence desires to follow the state LA Act, provisions of the relevant act can be referred to. Land Acquisition (LA) proposals are uploaded in 'Bhoomirashi Portal' namely http://bhoomirashi.gov.in. The stages involved in land acquisition process are presented below:

Appointment of CALA and 3(a) Publication

The Central Government appoints the Competent Authority for Land Acquisition (CALA) in exercise of its powers under Section 3(a) of the NH Act, 1956. As such, the CALA appointed by the Central Government, is obliged to take all actions for acquisition of land under the NH Act and the guidelines issued by the Central Government on the subject. As a general practice, Revenue Divisional Officer/Joint Collector in the District level is appointed as CALA.

Appointment of CALA is the first step of the LA process, who oversees the entire process of land acquisition, and acts as a liaison between the state government and the Executing Agency/ Authority.

"Competent Authority" means any person or authority authorised by the Central Government, by notification in the Official Gazette, to perform the functions of the competent authority for such area as may be specified in the notification;

"Land" includes benefits to arise out of land and things attached to the earth or permanently fastened to anything attached to the earth.

The 3 (a) Notification broadly describes about the list of villages through which the proposed alignment passes, the corresponding Police Stations, the Taluk, and District.

In normal practice, the process of "3(a)" notification is initiated by the respective executive agency and the following details are incorporated in Bhoomirashi Portal:

i) Project information
ii) Sanction details
iii) Detailed account of CALA(s)
iv) Name of the villages with Taluka & District where LA is to be done.

Subsequently, Government of India publishes a Gazette notification appointing the competent authority. The flow chart given below presents the process for 3a Gazette Notification/Publication.

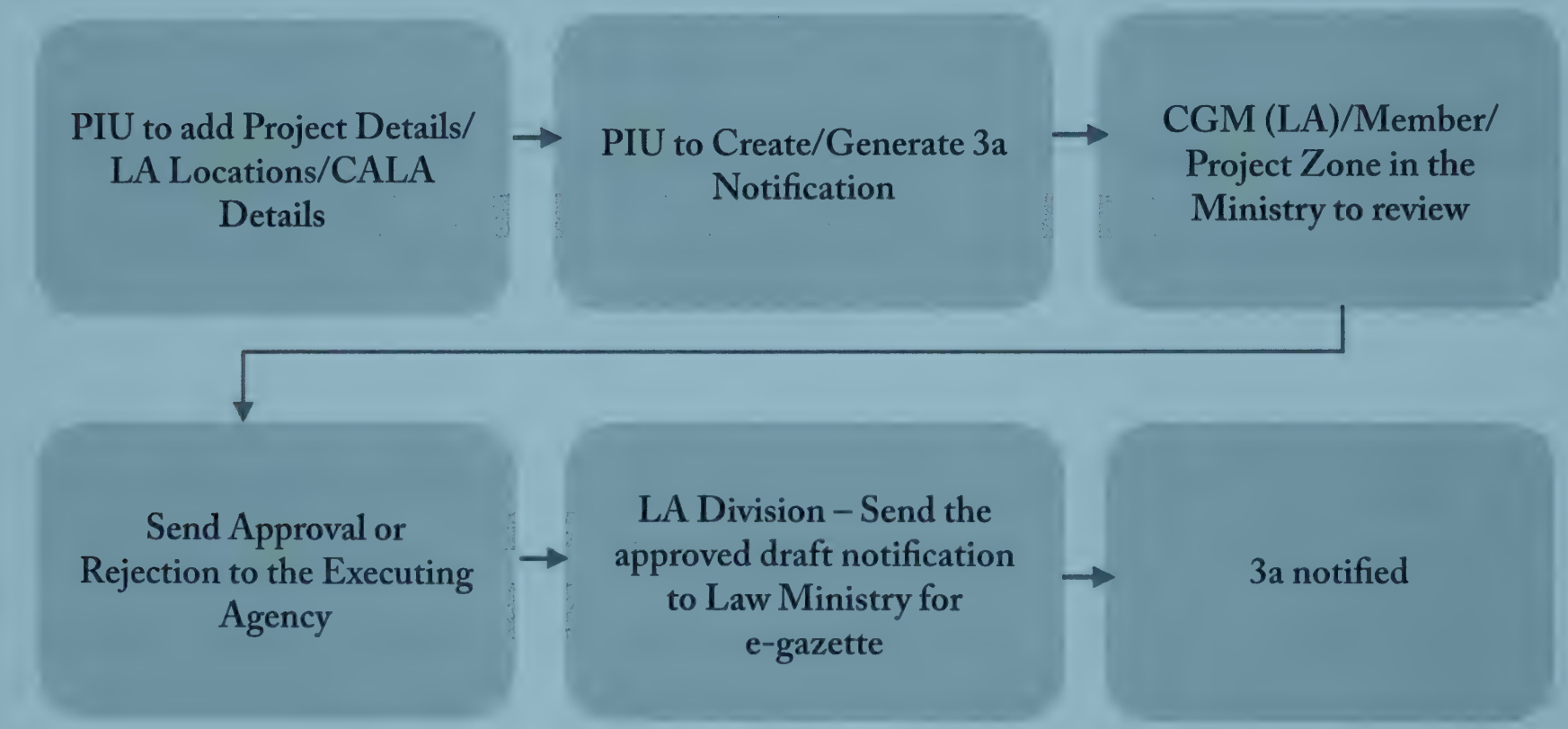

PIU to add Project Details/ LA Locations/CALA Details
PIU to Create/Generate 3a Notification
CGM (LA)/Member/ Project Zone in the Ministry to review
Send Approval or Rejection to the Executing Agency
LA Division – Send the approved draft notification to Law Ministry for e-gazette
3a notified

Fig. 18.1 Typical Flow Chart for Preparation of 3a Notification

Collection of Maps, Digitization and 3(A) Notification

The Central Government by publication of this Gazette under Section 3A of NH Act - Power to acquire land, expresses its intention to acquire such land for construction, maintenance and management of National Highways. The same shall be eventually intimated to the public through two local newspapers, one of which will be in vernacular language.

As part of preparation of 3 (A) notification, it is required to provide village wise details of affected survey numbers of the affected land, along with type and nature of the land. In addition to the above, Land Acquisition Plans (LAPs) shall be prepared for initiating the LA process. The area of the land under acquisition shall be provided in square hectares or square meters.

The procedure for preparation of LAPs and schedules (3(A)) is given in the following steps:

i) Collection of revenue maps from revenue authorities.

ii) Conversion of Village maps to TIF or JPG file after scanning
iii) Digitization of Scanned map using Auto CAD software
iv) Stitching the scanned maps using match lines
v) Correction of the final map using field data, specific features/land marks, images etc.
vi) Superimposition of the Final alignment of the Highway on the stitched map.
vii) Demarcation of the proposed Right of Way of Final alignment on the Map.
viii) Importing the digitized Map into GIS software.
ix) Identifying the affected survey numbers using GIS.
x) Estimation of the affected area Survey number wise/Sub-Division number wise using GIS.
xi) Preparation of the Draft Land Acquisition Schedule (3A) as per standard Gazette notification.
xii) Preparation of Village wise LAPs in the prescribed drawing format.
xiii) Submission of the Draft 3A to the user agency for verification and approval.
xiv) Verification of the proposed 3A notification by the concerned revenue authorities as per the direction of CALA.
xv) Preparation of Final 3A notification duly complying with the comments, if any.
xvi) Certification/Authentication of the 3A notification by CALA for Gazette Publication.
xvii) Uploading the 3(A) details in the Bhoomirashi Portal for approval and publication.
xviii) Publishing 3A Gazette notification by Government of India,
xix) Publishing the notification in the local newspapers, one in English and another in the vernacular language to make the public aware of the agency's intention to acquire the land for a specific purpose.

The flow chart given below shows the process of 3A Gazette Notification/Publication.

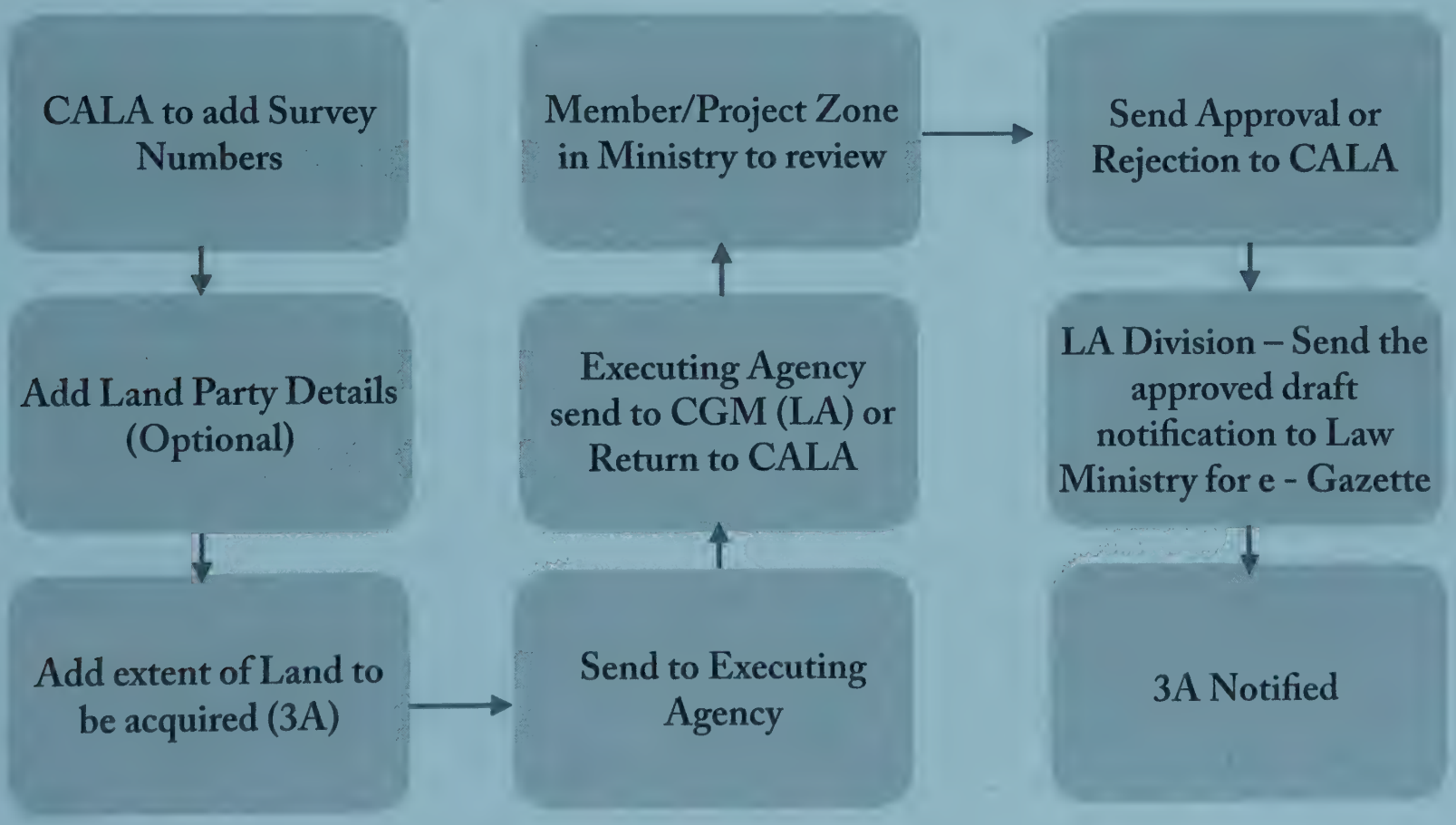

CALA to add Survey Numbers
Add Land Party Details (Optional)
Add extent of Land to be acquired (3A)
Send to Executing Agency
Executing Agency send to CGM (LA) or Return to CALA
Member/Project Zone in Ministry to review
Send Approval or Rejection to CALA
LA Division – Send the approved draft notification to Law Ministry for e - Gazette
3A Notified

Fig. 18.2 Typical Flow Chart for Preparation of 3A Notification

Section 3(A) – Power to enter for surveys

Following the gazette notification as per Section 3A, the Land Acquisition Officer or any Competent Authorities concerned in land acquisition and authorized by the Central Government can:

a) Make any inspection, survey, measurement, valuation or enquiry;
b) Take levels;
c) Dig or bore into sub-soil;
d) Set out boundaries and intended lines of work;
e) Mark such levels, boundaries and lines placing marks and cutting trenches;
f) Do such other acts or things as may be laid down by rules made in this behalf by that Government.

Section 3(C) – Hearing of objections

Subsequent to the Publication of 3 A Notification, objections receive from the affected parties shall be addressed.

i) Any person interested in the land may, within twenty-one days from the date of publication of the notification under sub-section (1) of section 3A, object to the use of the land for the purpose or purposes mentioned in that sub-section.
ii) CALA officials shall receive the public objections and schedule public hearings.
iii) CALA staff shall send notices to petitioners on respective hearing dates
iv) CALA's staff shall prepare a record of hearings, ensure compliance of corresponding orders and notify the final order to the petitioners
v) CALA shall have the power to either allow or disallow the objections.
vi) Any order made by CALA, the competent authority shall be final.

Joint Measurement survey and 3(D) Notification

(Section 3D – Declaration of Acquisition)

The Competent Authority (CALA) shall submit a report to the Government of India based on the Joint Measurement Survey (JMS) & Enjoyment Surveys conducted where the land is proposed under acquisition. The procedure involved in Joint measurement survey and preparation of 3D are described below:

Joint Measurement Survey

The user agency shall install the ROW Boundary Pillars for the purpose of Joint Measurement Survey, to be conducted by the Revenue Department officials as well as with the staff of Survey & Land Records Department of the State to determine the actual requirement of the land.

During the JMS, Survey number wise and Sub division number wise exact affected area of land and affected structures (i.e. bore-wells, trees, houses, etc.,) are measured. Further, JMS report is prepared & submitted to the CALA for review and approval. In order to facilitate the JMS Survey, the details of the ROW Pillars shall be marked on the digitized revenue map, where the individual survey numbers also are digitised and inserted. The sketch of the individual survey number along with the ROW Pillar and its distance from the nearest physical or identifiable revenue feature shall be marked too facilitate easy identification of the survey number and the confirmation of the affected area in the field. Such a method can hasten the process of JMS.

Enjoyment Survey

The enjoyment survey has to be conducted in order to identify the ownership of the affected land and the details shall be submitted to authority after verification by CALA. These surveys have to be conducted with utmost care as the final compensation shall be worked out based on these.

Preparation of "3D" notification

After completion of JMS & Enjoyment survey, revenue department shall prepare the JMS report along with LA sketches of individual survey numbers/sub-divisions. The Draft 3D notification shall be prepared by revenue authorities based on the JMS report and submitted to CALA for review and approval. Once approved, the Draft 3D notification shall be uploaded in the Bhoomirashi Portal.

The following flow chart shows the process of 3D gazette notification/publication.

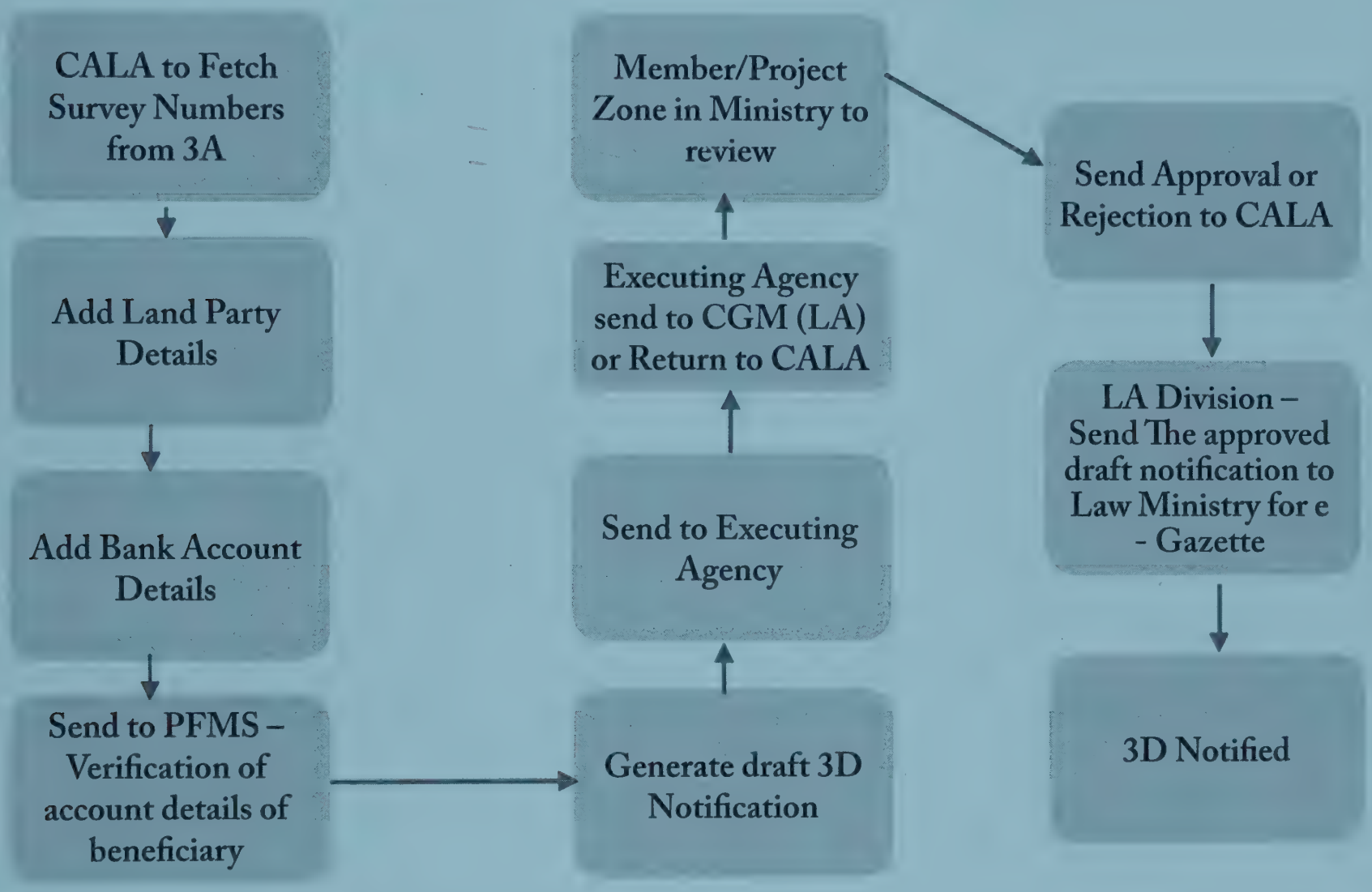

CALA to Fetch Survey Numbers from 3A
Add Land Party Details
Add Bank Account Details
Send to PFMS – Verification of account details of beneficiary
Generate draft 3D Notification
Send to Executing Agency
Executing Agency send to CGM (LA) or Return to CALA
Member/Project Zone in Ministry to review
Send Approval or Rejection to CALA
LA Division – Send The approved draft notification to Law Ministry for e - Gazette
3D Notified

Fig. 18.3 Typical Flow Chart for Preparation of 3D Notification

Section 3(E) – Power to take possession

The competent authority shall notify in writing to the owner as well as any other person who may be in possession of the land, to surrender the same to the competent authority (or any person duly authorised) within sixty days of the service of notice.

Notice shall be served to the beneficiaries for collection of award, and the certificate of possession shall be issued to the user agency/Authority. Section 3(F) – Power to enter into the land where land has vested in the central government

Any authorised official shall be able to enter the land and conduct activities of construction, maintenance, management or operation of the Project Highway.

Structure Evaluation, Award, 3(G) Notification, Compensation

Structure evaluation:

During the process of JMS, survey number wise and subdivision number wise affected structures (i.e. bore-wells, trees, houses, etc.,) shall be identified/ measured. Further, a report on affected structures shall be submitted to the respective Road & Buildings Department/Horticulture /Forest Department for validation and fixing-up the compensation.

Declaration of Award & Compensation disbursement

Public notice is published in two leading newspapers, one of which will be in, one in English and another in the vernacular language to invite claims from the affected land owners.

The current status of utilization of land shall be acquired and ownership status is ascertained from revenue records and local Panchayat office.

Land rates of various categories are collected from respective Collector/Sub Registrar offices.

Further steps would be:

i) Valuation and Calculation of land compensation payable and serving of compensation notices to the individual landowner and obtaining proper acknowledgment.

ii) Hearing and Recording of Claims

iii) Preparation of award of compensation to be paid to the landowners.

Section 3G – Determination of Amount Payable as Compensation

Compensation to be paid to the appropriate owner of the land for any land acquired under the Act shall be determined. 3G award along with valuation details is prepared for the approval of the CALA and the same shall be delivered upon approval. CALA staff shall prepare a field book which contains award by each beneficiary after 3G award is declared based on 3A, 3D and 3G notifications

Section 3H – Deposit and Payment of amount

The compensation amount determined as per Section 3G and payable to the persons entitled thereto, shall be deposited by the executing agency in the account of the CALA for payment to the affected persons. Alternatively, payment may be made to the affected persons directly through Bhumirashi or by other means as per the procedures in vougue.

This procedure is for the Projects using NH Act'1956 for land Acquisition. The User Agency using State LA Act shall follow relevant provisions of the Act.

18.4 Utility Shifting Proposals and Estimates

Various utilities are found in the existing and the proposed right of way (ROW), for which clearances are required from the concerned user departments, before relocating them out of the ROW.

Types of utilities

Different types of utilities generally observed along the project corridor are:

i) Electrical Poles and Lines
ii) High Tension Towers
iii) Water Supply Pipe lines
iv) Under Ground Drainage Pipes
v) Telephone Lines
vi) OFC Cables
vii) Gas Pipe Lines

a) Electrical Utilities

It is necessary to identify the electrical utilities falling within the proposed ROW and relocate them in the designated utility corridor inside/outside the proposed Right of Way. The utilities have to be inspected, enumerated and estimates for shifting them shall be prepared with the help of the user department. Such estimates have to be sent to the executing agency for approval so that the same can be shifted through a separate agency or the agency doing the civil works. Further, the executing agency is required to pay the supervision charges etc., as required and get the utilities relocated. In this regard, the details of the surface electrical utilities to be identified are:

a) Type of pole i.e. C.C, Steel, M type pole, Tower etc
b) Identification of Type of Transmission line i.e. LT,11 KV, 33 KV etc.

b) High Tension Towers

The organizations that are associated with the relocation of HT towers are Transco and Power grid. Details of the HT lines/towers to be identified in the field are:

a) Type of Transmission i.e. 132 KV, 220 KV, 330 KV, 440 KV etc.
b) Available Clearance of Transmission line above the proposed FRL of the road
c) Section of HT Line

c) Water Supply utilities

The organizations that are associated with the relocation of Water Supply are RWS, Public Health, Municipal Corporation and Panchayat Raj Departments. Joint Inspection has to be carried out with the concerned departments to identify the affected existing water pipe lines, water tanks etc., along the project corridor.

d) OFC Cable and Telephone lines

The organizations that are associated with the relocation of OFC Cables are BSNL, Reliance, TATA Teleservices, etc. Joint Inspection has to be carried out with the concerned departments to show the Utility Corridor, confirm if any of their utilities are passing through, so that these can be relocated in the designated utility corridor.

Identification of underground utilities

The overhead lines or surface utilities falling in the proposed ROW or affecting the construction can be identified easily. But, for identifying the underground utilities Ground Penetration Radar (GPR) is used. Ground Penetration Radar can be used to screen all the underground utilities like electrical cables, water pipelines, OFC cables, etc.

GPR can be run longitudinally on the existing road/project alignment and any incidence of utility crossing can be identified. Later, it can be run across the road at an interval of 250 m or higher, and any incidence of longitudinal pipelines can be identified. Wherever required, it can be run at closer intervals to determine the exact length and location of the utility. Depth of utility also can be determined by this equipment. By using a GPR of proper configuration, it is also possible to identify the cross drainage structures and the pavement composition.

It is a non-destructive method which uses electromagnetic radiation in the microwave band (UHF and VHF frequencies) of the radio spectrum to detect the reflected signals from subsurface utilities.

Preparation of Utility Relocation Plans

After completion of the above field enumeration, affected surface & sub-surface utility plans shall be generated by using Auto CAD & GIS software based on the information collected from all the utility agencies in the region and maps/plans available with executive agencies .

Consultation will be done with local people, Panchayat, municipal authorities to ascertain the presence and location of utilities. Field visits will be conducted along with the user agencies/ departments owning the Services. Utility Relocation Plans shall be submitted to the concerned agencies showing the affected utilities and the designated corridor for shifting the same.

Clearance for Gas pipelines

The organizations that are associated with Gas pipe lines are ONGC, HPCL and GAIL etc. Joint inspection with the concerned officials shall be organized to identify the affected gas pipe lines all along the project corridor. Based on the site visit best feasible option (GADs) shall be prepared to accommodate the Gas pipe line with proper care and safety features. Finalized GAD shall be submitted to the concerned agencies for obtaining NOC. Sometimes, new structures may have to be built for protecting the gas lines crossing the project highway. The tentative location of gas lines can be obtained from the agencies' web sites or other portals, which can be used to avoid the conflict with gas lines in the first place

Activities involved in obtaining Utility Shifting Estimates

a) Identification of utilities falling in the existing/proposed right of way that require relocation to enable construction of the proposed project road.

b) Incorporation of the space required for relocating elevated and under-ground utility corridors and utilities crossings as required for existing and future utilities in consultation with user departments

c) Obtaining draft utilities shifting proposal from user departments for all utilities identified for shifting along project road

d) Preparation of utility shifting cost estimates using latest schedule of rates and seeking approval from user departments

e) Review of final designs submitted, cost estimates, completion of checklist, obtaining the required declarations.

f) Coordination with the user department to incorporate any changes requested in shifting proposal and cost estimate.

g) Procuring all the required utilities shifting proposal estimates and required approvals from user department

18.5 MOEF & CC Clearance

Development of a Project Highway attracts various International, National, State and World Bank environmental laws, rules and regulations. These regulations and rules are helpful in impact mitigation and improvement of the environment. As per EIA Notification 2006 and subsequent amendments, various norms listed based on the type of project proposal shall require prior environmental clearance. The Project Proponent shall be responsible for procuring environmental clearance from Ministry of Environment and Forests (MoEF & CC), prior to execution of the civil works of a road project.

Environmental Clearance (EC) is necessary if:

a) The project alignment passes through reserve forest, sanctuaries, national parks, protected natural reserves etc.
b) All new National and State Highways including Expressways
c) Expansion of National Highways greater than 100 km involving additional RoW or land acquisition greater than 40 m on existing alignment and 60 m on re-alignments or bypasses
d) If there are plantations on the RoW, that are notified as Protected Forests
e) State Highway expansion projects in hilly terrain (above 1000 m AMSL) and or ecologically sensitive areas.

Forest Clearance (FC) is necessary for:

All State Highways and National Highways including Expressways passing through notified forest (Reserved, Protected or any other).

18.5.1 *Process of obtaining Environmental Clearance is as follows:*

a) User Agency to upload Form I (Pre-Feasibility Report TOR) in the MoEF & CC web portal (https://parivesh.nic.in) for approval of TOR.
b) Environmental Advisory Committee (EAC), MoEF & CC, New Delhi to hold a review meeting to know the necessity and requirement of the project corridor.
c) EAC/SEAC to recommend TOR and forward to MOEF & CC/SEIAA for grant of ToR and conducting EIA studies.
d) User agency or the agency deployed by the user agency shall commission Environmental base line studies for the project corridor as per the approved TOR, and prepare the Environmental Impact Assessment (EIA) Report
e) User Agency to organize Public hearing through State Pollution Control Board (SPCB).
f) Prepare final EIA report based on the above studies & outcome of the public hearing and submit to MoEF along with copy of FSR/DPR through user agency for obtaining clearance.
g) User agency along with QCI/NABET approved Consultants to make a detailed presentation on EIA to Expert Appraisal Committee (EAC/SEAC) at MoEF & CC, New Delhi for obtaining final approval of EIA Report.
h) Procure the Environmental Clearance from MoEF&CC duly complying with the comments given during EIA presentation and submit the same to the user agency.

PARIVESH
परिवेश
About MoEFCC
Acts, Rules & Guidelines
Notifications
Agenda & MoM
Track your proposal
E-Job
Useful Links
Downloads
Contacts
FAQs
PARIVESH
परिवेश
Forest, Wildlife and CRZ Clearances
Project Proponent
State Processing Authority
Central Processing Authority
PARIVESH is a web based, role based workflow application which has been developed for online submission and monitoring of the proposals submitted by the proponents for seeking Environment, Forest, Wildlife and CRZ Clearances from Central, State and district level authorities. It automates the entire tracking of proposals which includes online submission of a new proposal, editing/updating the details of proposals and displays status of the proposals at each stage of the workflow.
ENVIRONMENT CLEARANCE
FOREST CLEARANCE

A Snap shot of the MoEF&CC Web site

No Objection Certificate has to be obtained from State Pollution Control Board as part of requirement for obtaining Environmental Clearance.

18.6 Forest Land Diversion

Diversion of forest land for non-forest purpose shall be done under the provisions of the Forest Conservation Act 1980 and Forest Conservation Rules 2003.

Further the Ministry also provided several explanations and exemptions from time to time though various GOs to enable the process of diverting the forest land for non-forest purposes.

The Ministry also published a Handbook on Forest Conservation Act to enable the process. The latest Handbook was published in the year 2019.

The definition of forest is enshrined in the Act. However, by its order of 1996, the Supreme Court of India has extended the provisions of the Act to all forests, irrespective of ownership (including 'forests" as understood in the dictionary sense)

I. Procedure to be adopted for diverting the forest land for linear projects or Roads

STAGE – 1

Preparation of Form – A of Part – I

a) After the finalization of the proposed alignment of the road, Forest patches intervening with the proposed road shall be identified. The same shall be confirmed by the forest department in their pre-proposal visit.

b) Based on the data, the **Form – A** of part – I would be developed with required Maps, certificates and undertakings as required.

c) In some states the DGPS survey of the proposed forest patches for diversion is a prerequisite for the preparation of the **Form – A**. In such cases the project proponent shall submit the raw data of the DGPS survey conducted by any authorized agency and get it authenticated by the forest department.

Online Submission of the Form – A of Part – I

a) The project proponent shall register on 'PARIVESH' the designated web portal of the Ministry of Environment, Forest and Climate Change (MoEF&CC) as a user agency.

b) Based on the data of the identified forest patches, the form – A shall be uploaded, with all the required Maps, KML files, certificates and undertakings. Authenticated DGPS maps and their corresponding KML files only be uploaded.

c) Thus, submitted Form – A will be reviewed by the concerned state Nodal officer and if found correct the same would be forwarded to the concerned DFOs and district collectors for further action.

d) At this stage the forest department would ask the Project proponent to submit 4-8 sets of hard copies of the proposal (with original signatures of the project proponent) to DFO and 1 copy to DC.

e) The DFOs after conducting site inspection of the proposed forest patches for diversion would forward the same to the concerned Conservator of Forests (CF) by filling up the Part – II limited to his/her jurisdiction with comments and recommendations.

f) In case of State Government projects, the Project Proponent shall identify non forest land for Compensatory Afforestation (CA), equal to the area proposed for diversion, certified by the DFO. If non forest area for Compensatory afforestation is not available, then a certificate from the Chief Secretary of the state shall be submitted by the Project Proponent stating that land for CA is not available hence, the CA land may be identified in any other state by the Ministry.

g) In case of Central Government projects, the State forest department has to identify the land for CA. The CA land would be double the area proposed for diversion. Further the DFO shall prepare a scheme for afforestation and include the same with the part–II.

Processing of the proposal at various stages of the Forest Department

a) The Conservator of forests after receiving Part – II filled up by concerned DFO would forward the same to the Nodal officer by mentioning comments and recommendations in Part – III

b) The Nodal Office after verifying the merit of the case would forward it to the Secretary (forest department) of the state by filling comments and recommendations in Part – IV of the proposal.

c) The Secretary forest department would forward the same to the Regional Empowered Committee of MoEF and CC by signing in Part–V of the proposal, with a copy to the Nodal officer to present the proposal to the Chairperson of Regional Empowered Committee directly, if the proposed land for diversion is less than 40Ha.

d) If the proposed land for diversion is more than 40Ha the proposal shall be sent directly to the Secretary to the Government of India, Ministry of Environment and Forests, Paryavaran Bhavan, CGO Complex, Lodhi Road, New Delhi-110 003, with a copy of the proposal (with complete enclosures) to the concerned Regional Office as per the rules framed for the Forest Conservation Act in 2003.

Approval Process at the Regional Empowered Committee (REC) of the MoEF&CC

a) If the proposed land for diversion is less than 5Ha, the Chairperson of the REC would make a decision without calling for the REC meeting.

b) If the proposed land for diversion is 5 – 40 Ha, the proposal will be discussed by the REC based on the recommendations of the committee and a decision is made.

c) If the proposed land for diversion is more than 40Ha, the proposal will be discussed in the REC meeting and its recommendations will be sent to the Secretary, MoEF and CC, for final decision.

d) If the proposed land for diversion is more than 100 Ha, the REC has to conduct site inspection and then the recommendations of the committee will be sent to the Secretary, MoEF and CC, for final decision.

e) Execution of the project can be started after the Stage – I clearance is accorded by making payment towards the demand raised by the forest department.

f) While this process is going on, the Project Proponent shall try and submit the certificate in the prescribed format from the concerned district collector about the status of settlement of rights of the forest dependent communities as per the provisions of the Forest Rights Act – 2006.

g) As per the extant policy, Project Proponent can submit the certificate under FRA – 2006, till the stage – II clearance is accorded.

18.7 Clearance from the National Board of Wild Life (NBWL)

The National Board for Wildlife (NBWL) is constituted by the Central Government under Section 5 A of the Wildlife (Protection) Act, 1972 (WLPA)

In case the proposed alignment is passing through Wildlife Sanctuary or Protected Forest or National Parks, clearance under the Wildlife Act of 1972 is a prerequisite.

Procedure to be adopted for Clearance from the NBWL

a) After the finalization of the proposed alignment of the road, if the prosed alignment is passing through any Wildlife Sanctuary or Corridor or Protected Forest or National Park area, the user agency shall approach the concerned DFO or DCF of the wildlife division and get the area confirmed by organizing a pre-proposal visit.

b) The process of wildlife clearance as well as the forest land diversion can be initiated simultaneously.

c) Preparation of the Part – I of the wildlife clearance proposal with all supporting documents shall be uploaded on the designated web portal of the MoEF and CC 'PARIVESH'

d) After reviewing the proposal with all necessary documents, the CCF – Nodal, would forward the same to the concerned DCF

e) The DCF after conducting the site inspection, would forward the proposal to the State wildlife Warden, with comments and recommendations in Part–II.

f) The Wildlife Warden upon receiving the part – II from the concerned DCF, would forward the proposal to the CCF- Nodal, by filling Part–III.

g) At this stage, the forest department would ask the Project Proponent to submit 18 sets of the hard copy of the proposal (with original signatures of the Project Proponent)

h) The CCF – Nodal would forward the proposal to the State government by recommending the same in part – IV, to discuss in the State Board for Wildlife (SBWL), Chaired by the Chief Minister.

i) Based on the recommendations of the SBWL, the proposal will be forwarded to the NBWL through the secretary, MoEF and CC.

j) The NBWL, would review the proposal and make the final decision.

k) The diversion of forest land falling in the wildlfie sanctuaries or protected areas or national parks is subject to the clearance from the NBWL.

18.8 Coastal Regulatory Zone (CRZ) Clearance

Classification of CRZ:

a) **CRZ – I:**

These areas are environmentally most critical and are further classified as under:

CRZ – IA: shall constitute the following Ecologically Sensitive Areas (ESAs) and the geomorphological features which play a role in maintaining the integrity of the coast.

a) Mangroves (in case mangrove area is more than 1000 square meters, a buffer of 50 meters along the mangroves shall be provided and such area shall also constitute CRZ–I A)

b) Corals and coral reefs

c) Sand dunes

d) Biologically active mudflats

e) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986), including Biosphere Reserves

f) Salt marshes

g) Turtle nesting grounds

h) Horseshoe crabs' habitats

i) Sea grass beds

j) Nesting grounds of birds

k) Areas or structures of archaeological importance and heritage sites

CRZ – IB: The intertidal zone i.e. the area between Low Tide Line* and High Tide Line** shall constitute the CRZ-I B.

b) **CRZ – II:** shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban

areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

c) **CRZ – III:** Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ–III, and CRZ-III shall be further classified into the following 2 categories.

CRZ – IIIA:

Such densely populated CRZ-III areas, where the population density is more than 2161 per square kilometer as per 2011 census base, shall be designated as CRZ–III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)', provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of 200 meters shall continue to apply.

CRZ – IIIB:

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011 census base, shall be designated as CRZ-III B, and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)'.

Land area up to 50 meters from the HTL, or width of the creek whichever is less, along the tidal influenced water bodies in the CRZ III, shall also be earmarked as the NDZ in CRZ III.

d) **CRZ – IV:**

The CRZ- IV shall constitute the water area and shall be further classified as under:

CRZ – IVA:

The water area and the seabed area between the Low Tide Line, up to twelve nautical miles on the sea side shall constitute CRZ-IV A.

CRZ – IVB:

Areas shall include the water area and the bed area between LTL, and the tidal influenced water body, where and to the extent the salinity is greater than five parts per thousand (ppt) during the driest season of the year.

Procedure for CRZ clearance for permissible and regulated activities:

The Project Proponent shall apply with the following documents to the concerned State or the Union territory Coastal Zone Management Authority for seeking prior clearance as per CRZ notification.

a) Project summary details to be provided as per details mentioned in the CRZ notification. (Refer **Annexure-V** of CRZ notification).

b) Rapid Environment Impact Assessment (EIA) Report shall be submitted including marine and terrestrial component, as applicable. Rapid EIA report is not required for building construction projects or housing schemes.

c) Comprehensive EIA with cumulative studies for projects, (except for building construction projects or housing schemes with built-up area less than the

threshold limit stipulated for attracting the provisions of the EIA Notification, 2006 number S.O 1533(E), dated 14th September, 2006) shall be carried out if located in low and medium eroding stretches, as per the CZMP of CRZ notification.

d) Submit Risk Assessment Report and Disaster Management Plan, except for building construction projects or housing schemes with built-up area less than the threshold limit stipulated for attracting the provisions of the EIA Notification, 2006 number S.O 1533(E), dated 14th September, 2006).

e) CRZ map in 1:4000 scale, drawn up by any of the agencies identified by the Ministry of Environment, Forest and Climate Change vide its Office Order number J-17011/8/92-IAIII, dated the 14th March, 2014 using the demarcation of the HTL or LTL, as carried out by National Center for Sustainable Coastal Management.

f) Project layout superimposed on the CRZ map duly indicating the project boundaries and the CRZ category of the project location as per the approved Coastal Zone Management Plan of CRZ notification.

g) The CRZ map normally covering 7 kilometer radius around the project site shall be submitted indicating the CRZ-I, II, III and IV areas including other notified ecologically sensitive areas.

h) "Consent to establish" or No Objection Certificate from the concerned State Pollution Control Board or Union territory Pollution Control Committee for the projects involving treated discharge of industrial effluents and sewage, and in case prior consent of Pollution Control Board or Pollution Control Committee is not obtained, the same shall be ensured by the proponent before the start of the construction activity of the project.

i) The concerned Coastal Zone Management Authority shall examine the documents in Clause above, in accordance with the approved Coastal Zone Management Plan and in compliance with CRZ notification and make recommendations within a period of sixty days.

j) The Ministry of Environment, Forest and Climate Change shall consider complete project proposals for clearance based on the recommendations of the Coastal Zone Management Authority, within a period of sixty days.

k) In case the Coastal Zone Management Authorities are not in operation due to their reconstitution or any other reasons, then it shall be responsibility of the Department of Environment in the State Government or Union territory Administration, who are the custodians of the CZMP of respective States or Union territories, to provide comments and recommend the proposals in terms of the provisions of the said notification.

l) The clearance accorded to the projects under this notification shall be valid for a period of seven years, provided that the construction activities are completed, and the operations commence within seven years from the date of issue of such clearance.

m) The validity may be further extended for a maximum period of three years, provided an application is made to the concerned authority by the applicant within the validity period, along with recommendation for extension of validity of the

clearance by the concerned State or Union territory Coastal Zone Management Authority.

Post clearance monitoring:

a) It shall be mandatory for the Project Proponent to submit half-yearly compliance reports in respect of the stipulated terms and conditions of the environmental clearance in hard and soft copies to the regulatory authority(s) concerned, on the 1st June and 31st December of each calendar year and all such compliance reports submitted by the project proponent shall be published in public domain and its copies shall be given to any person on application to the concerned Coastal Zone Management Authority. The compliance report shall also be displayed on the website of the concerned regulatory authority.

b) To maintain transparency in the working of the Coastal Zone Management Authority, it shall be the responsibility of the Coastal Zone Management Authority to create a dedicated website and post the agenda, minutes, decisions taken, clearance letters, violations, action taken on the violations and court matters including the Orders of the Hon'ble Court as also the approved CZMP of the respective State Government or Union territory.

Areas requiring special consideration in the CRZ

Following coastal areas shall be accorded special consideration for the purpose of protecting the critical coastal environment and difficulties faced by local communities.

a) Critically Vulnerable Coastal Areas (CVCA): Sundarban region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 such as Gulf of Khambat and Gulf of Kutchh in Gujarat, Malvan, Achra-Ratnagiri in Maharashtra, Karwar and Coondapur in Karnataka, Vembanad in Kerala, Gulf of Mannar in Tamil Nadu, Bhaitarkanika in Odisha, Coringa, East Godavari and Krishna in Andhra Pradesh shall be treated as Critical Vulnerable Coastal Areas (CVCA) and managed with the involvement of coastal communities including fisher folk, who depend on coastal resources for their sustainable livelihood.

b) CRZ for inland Backwater islands and islands along the mainland coast.

c) CRZ falling within municipal limits of Greater Mumbai.

18.9 Procurement of Clearance from Railways for ROB, RUB etc.

a) It is the Executing Agency's obligation to procure the approval of the Railways for the ROBs, RUBs or any similar structures to be constructed across a railway line within the Right of Way of the Railways Department. Process of obtaining ROB clearance is as follows:

b) GAD shall be prepared based on the field studies conducted at the proposed crossing. During the field visit following details shall be identified:

   a) Right of Way of the Railway boundary
   b) Nearest existing LC (Level crossing) number
   c) Nearest Railway station
   d) Existing railway chainage

A) Proposed GAD shall be uploaded by the executing agency in the Road Rail Crossing GAD approval system (RORACS) web portal (https://ircep.gov.in/RCApproval).

B) Joint site visit shall be organized with the concerned Railway authorities for field verification.

C) Joint feasibility report shall be prepared and uploaded in the RORACS web portal based on the inspection.

D) Based on the observations of the Railways, the GAD shall be revised.

E) Revised GAD shall be uploaded in the RORACS web portal for approval.

F) Planning & Estimation and Way –leave charges shall be paid by the executing agency.

G) Thereafter, an MoU shall be made between Railways and the executing agency.

H) A snapshot of the RORACS system is presented below.

Rail-Road Crossing GAD Approval System
Login
Login Id
Password
Mr. Nitin Gadkari Hon'ble Minister of MORTH appreciates benefits of this application... TOI
Proposals can be entered and monitored by NHAI authorised officials from this website. Certain useful drawings and documents are linked below:
1. Standard Spans for Railway portion
2. Sample GAD
3. Guidelines for Planning of Road Over Bridges RDSO Report No. BS - 112
4. Data for Planning of Road Over Bridges CRS/DRO Letter
5. MOU between Ministry of Railways & Ministry of Road Transport
6. Ministry of Road Transport Letter
You are not logged in, or Session has expired!!!
Designed & Developed by Centre for Railway Information System
CRIS

A Snap Shot of RORACS for uploading ROB details

18.10 Tree Felling Permission

Trees which are affected due to project proposals shall be clearly identified, properly blazed and numbered during the enumeration. Tree enumeration shall be carried out girth-wise & species-wise. The trees whose girth size is 30 cm and more shall be considered for enumeration. The girth of a tree shall be measured at a height of 100 cm from ground. The following details shall be collected of each tree:

a) Name of the Tree (Local/Scientific)
b) Girth of the Tree
c) Height of the Tree
d) Height of the stem
e) Distance from existing road centre line
f) Condition of wood (if possible)

Further, requisition form shall be submitted to competent authority (DFO) through user agency for obtaining felling permission. Joint field verification has to be carried out with concerned forest/ revenue officials for approval of enumeration report. No Objection Certificate (NOC) has to be obtained for felling of roadside trees, which have been planted by individuals, and the Planning and Extension Division of the Forest Department, R&B and Highways. The current Upset Price and tree felling estimates shall be obtained from concerned forest officials. The felling permission and its value for fruit bearing trees shall be obtained from Horticulture/revenue departments as per WALTA/State Government rules.

18.11 Clearance for Irrigation Canals

The organizations that are associated with irrigation canals is respective State Water Resource/ Irrigation department. Joint inspection with the concerned officials shall be organized to identify the affected irrigation canals all along the project corridor. Based on the site visit best feasible option (GADs) shall be prepared to accommodate irrigation canal with proper care and safety features. Finalized GAD shall be submitted to the concerned agencies for obtaining approval and NOC.

18.12 Clearance for Underpasses/Overpasses

Permission shall be obtained from the local R&B Department/PRED/MORTH etc. for the proposals made on the cross roads, in respect of the roadway width, the clearances and the profile of the cross road. The development plans of the concerned departments for the cross roads shall be taken into consideration before designing the profile and the junctions at those locations.

APPENDIX-1

GUIDING PRINCIPLES COVERING ROUTE SELECTION AND HIGHWAY LOCATION

1. General

1.1 The highway should be as direct as possible between the cities or towns to be linked, thereby, satisfying the major desired links. A direct highway link results in economy in construction, maintenance and operation.

1.2 The location should result in minimum interference to agriculture and industry.

1.3 The location should, as far as possible, facilitate easy grades and curvature.

1.4 The location should steer clear of obstruction, such as, cemeteries, burning ghats, places of worship, archaeological and historical monuments, and as far as possible, from public facilities, like, hospitals, schools, playgrounds, etc.

1.5 Where the proposed location interferes with utility, services, like, overhead transmission lines, underground water supply lines, sewerage lines, gas lines etc., decision between changing the highway alignment or shifting the utility services should be based on study of the relative economics and feasibility.

1.6 As far as possible, frequent crossing and re-crossing of a railway line should be avoided. For design requirements in such cases, reference may be made to IRC:39 "Standards for Road-Rail Level Crossings".

1.7 An important obligatory point in the selection of the route is the location of river crossings. While crossings of major rivers (waterway exceeding 200 m.) may have to be as normal to the river flow if possible, with highway alignment sub-ordinated to considerations of the bridge siting. Crossings of medium/minor streams should be generally governed by the requirements of the highway proper. If necessary, such structures could be made skew/ located on curves.

1.8 The location should be such that the highway is fully integrated with the surrounding landscape of the area. In this connection, it would be necessary to study the environmental impact of the highway and ensure that the adverse effects of it are kept to the minimum.

1.9 The highway should, as far as possible, be located along the edges of properties rather than through their middle so as to cause least interference to cultivation and other activities and to avoid the need for frequent crossing of the highway by the local people.

1.10 The location should be, such as, to avoid unnecessary and expensive destruction of wooded areas. Where intrusion into such areas is unavoidable the highway should be aligned on a curve if possible so as to preserve an unbroken background.

1.11 The location should, as far as possible, be close to sources of embankment and pavement materials so that haulage of these over long distances is avoided and the cost minimized.

1.12 A preferred location is one which passes through areas having better type of soil and permits a balancing of the cost of cut and fill for the formation.

1.13 Marshy and low-lying land, and areas having poor drainage and very poor embankment material should be avoided, as far as possible. Also, areas susceptible to subsidence due to mining operations should be by-passed.

1.14 Areas liable to flooding should be avoided, as far as possible.

1.15 Highways through villages and towns increase traffic hazards and cause delay and congestion. Wherever a serious problem of this nature is encountered it may be advisable to by-pass the built-up area playing well clear of the limits upto which the town or village is anticipated to grow in the future.

1.16 As far as possible, areas likely to be unstable due to toe-erosion by rivers, shall be avoided.

1.17 During fixing of alignment by the side of a river, the direction of flow of the river and HFL records for past 50 years shall be kept in view.

1.18 In spite of all conscious effort to avoid running through forest areas many times roads are required to be aligned passing through the forest land. With increase in traffic roads require to be widened often leading to cutting of trees on one or both sides of the road. All this unavoidable felling needs to be made good by provision of compensatory afforestation in equal or additional areas at suitable locations. Project preparation needs to keep this aspect in view and make necessary provisions for compensatory afforestation where the same is warranted.

1.19 If prior to project preparation it is known that a facility under construction is to be widened to additional lanes, the project should be prepared by locating the first embankment and pavement in an eccentric position with respect to the total land available and also freeze the total land required for the entire envisaged facility right in the beginning. The subsequent construction may then be undertaken symmetrically with respect to the center line of the land.

If provision of additional lanes has to be made to an old road, it can be done either by addition of half the requirement symmetrically on each side on the entire new addition on one side only. The points to be considered in such a case are:

i) the availability of land and convenience of additional acquisition in view of presence of buildings and existing constructions on each side

ii) felling of trees that may be involved on either side

iii) the width of new construction and facility of compaction equipment to operate and

iv) technical convenience for construction of additional structures and necessary protection works for the same in the vicinity of the existing structures

v) Technical convenience for locations of additional two-lane carriageway preferably on upstream side of the flow of water, providing better protection to the existing facility.

1.20 The location should, as far as possible, to avoid or minimize the CRZ areas while planning the highway in coastal region.

1.21 Defense establishment, future development of Airport Areas should be avoided, as far as possible

2. Special Problems of Locating in Hilly Areas

2.1 The route should enable the ruling gradient to be attained in most of the length.

2.2 Steep terrain and other inaccessible area should be avoided, as far as possible.

2.3 Unstable hilly features, areas having frequent landslide or settlement problems and up slope benched agricultural field with potential for standing water may be avoided as far as possible.

2.4 Locations, along a river valley have the inherent advantage of comparatively gentle gradients, proximity of inhabited villages, and easy supply of water for construction purposes. However, this solution is be-set with disadvantages, such as, the need for large number of cross-drainage structures and protective works against erosion. It would, therefore, be necessary to take the various aspects into account before making the final selection.

2.5 The alignment should involve least number of hair-pin bends. Where unavoidable, the bends should be located on stable and gentle hill slopes.

2.6 In certain cases, it may be expedient to negotiate high mountain ranges through tunnels. For such cases, the decision should be based on relative economics or strategic considerations.

2.7 In crossing mountain ridges, the location should be such that the highway preferably crosses the ridge at their lowest elevation.

2.8 An alignment likely to receive plenty of sunlight should receive due preference over the one which will be in shade.

2.9 Areas liable to snow drift should be avoided.

2.10 As far as possible, needless rise and fall must be avoided, specially where the general purpose of the route is to gain elevation from a lower point to a higher point.

2.11 Areas of valuable natural resource and wildlife sanctuaries shall be avoided.

3. Special Consideration for Locating Roads in Desert Area

3.1 Locations where sand is loose and unstable should be avoided and the alignment selected along ridges having vegetation.

3.2 Preference should be given to areas having coarse sand than to areas having fine windblown sand.

3.3 In locating a road in an area having longitudinal sand dunes, the best location is always at the top of a ridge or in the inter-dunal space. Location along the face of longitudinal dunes should be avoided.

3.4 The alignment of road should as far as possible run parallel to sand dunes, sand dunes should be crossed without disturbing their existing profile.

4. Special Considerations in Expansive Soils

4.1 Suitable forms of stabilization, specially mixing of lime in pulverized soil may be necessary to achieve desired gain in strength.

5. Special Considerations of Road in Saline Soils

5.1 Locations where large salt deposits occur should be bypassed.

5.2 In locating the road in medium and highly saline soil precautions for diversion of water away from road bed should be taken.

5.3 On wet saline soils, highway embankment should be constructed of good imported soil free from salts.

6. Special Consideration in Marine Clay

In case the marine clay site is under the influence of tide rise and fall of water, the subgrade should be 1.0 meter above the highest tidal water level.

Marine clay are soft and compressible. Therefore, stability of fill and the magnitude and time rate of settlement needs to be evaluated and considered. If these factors are not within the acceptable limit ground improvements methods may be adopted.

7. Special Consideration in Water Logged Areas

7.1 Embankment height should be adequately above level of standing water.

7.2 Provision of capillary cut-off or blanket drainage facility below pavement may be necessary.

8. Points of Guidance on Prevention of Soil Erosion needing attention in the Construction of Road in Hilly Areas:

8.1 The road construction project estimates should provide for not only the requisite scale of investigation but also the necessary measures against soil erosion so that these can be built into the project with adequate financial provision.

8.2 Before finalizing the alignment erosion potential of each alternative should be carefully examined and the one involving least disturbance to the natural ground should be preferred.

8.3 Roads should not be located in geological by unstable strata, if this can be avoided. Study of the geological maps of the area and consultation with the local Geological Department will be helpful in this regard.

8.4 Road alignment should avoid large scale cutting and filling and follow the profile of the land as far as possible. Use of tunnels to avoid deep cuts should be considered where feasible and economical.

8.5 To the extent feasible, roads should be aligned away from streams except where these are to be crossed, since the greatest damage always occur along water courses. Special attention is necessary to create protective belts of forests on both sides.

8.6 It will be advisable, at least for important roads, to have consultation with officers of Forest Department at the stages of route alignment selection, surveys and

investigations, etc., so as to ensure that the selected alignment has minimum potential for soil erosion and that the project designs and estimates provide for the necessary soils erosion control measures.

8.7 On hill Slopes half cut and half fill type of cross-section which involves least disturbance to the natural ground, should be adopted subject to consideration of economy and road stability being satisfied.

8.8 The cut slope should be made stable for the type of strata in the initial construction stage itself by resorting to stable cut slopes with benches, etc., including the use of slope stabilizing structures, like, breast walls, pitching, etc.

8.9 Area for clearing and grubbing should be kept minimum subject to technical requirements of the road. The clearing area should be properly demarcated to save desirable trees and shrubs and to prevent over clearing.

8.10 Location and alignment of culverts should be so chosen as to avoid adverse erosion at outlets and siltation at inlets.

8.11 The cross-drainage structures should discharge safely on the valley side and in this connection all necessary precautions/safe guards should be taken to ensure that the discharging water does not cause erosion even when they flow for long period.

8.12 Drainage of water from the roadside must be given top attention and necessary system of drains will be received to deal the run-off to natural water courses.

8.13 Appropriate mitigating Pleasures, like, ground cover planting and compulsory afforestation may be catered for.

TRAFFIC GROWTH RATE ESTIMATION

1.1 Traffic growth rate is required to be estimated to assess the future corridor traffic. To be realistic, this projection must be made by considering traffic flow pattern by Origin-Destination pairs and changes in vehicle mix expected during the time horizon of the study. Since the transport demand can change due to shift in the pattern of economic activities, it is also necessary to consider trip generation potentials within a region. In view of this, projecting regional socio-economic characteristics, plus the rate of change likely to take place in the economy, the population size, urbanization and the spatial distribution of the economic activities are required to be considered in estimation of growth rate for traffic projection. Simple methods which may be considered suitable are described below:

1.2 Time Trend Analysis

For this purpose classified volume count data are to be collected at selected survey locations, which are reasonably representative of the traffic flow conditions along the corridor.

The analysis is then carried out generally by Linear Regression Analysis. AR2 value of 0.75 or more would be acceptable for forecasting. Erratic and scattered values of R may require consideration of other parameteres and appropriate unbiased purification of data base or adjustment of growth rates. Nevertheless, this method has its limitations particularly in its applications to a new facility. Secondly, historical growth rates do not cover the changes in the socio-economic structure, as such, fail to reflect fully the prospective growth envisaged in the economy and the spatial distribution of economic activities, population size and, urbanization. These may require some zonal-level forecasting along the corridor. Thus, something more than simple extrapolation of historical growth rates by vehicle type is required.

1.3 Systematic Forecasting Method

This method is more related to the projections of Origin-Destination linkages at the zonal-level, as related to the prospective growth in population and the economy.

The traffic forecasting models developed for the study involve the estimation of future transport demand, in terms of future growth rates based on the growth of population and Net State Domestic Project (NSDP), together with the elasticity of transport demand for both passengers and freight, in relation to income and population.

The data inputs required by this method for the determination of growth rates of vehicular traffic comprise:

a) the growth of population
b) income (in real terms) and
c) the elasticity of transport demand in relation to population and income

The data, particularly the income and transport demand elasticity, are generally not available at zonal level, the state level data may be used with due consideration of the zone under consideration.

1.4 Simplified Approach

This approach is primarily based on the broad guidelines for economic analysis for highway investments circulated for schemes under the proposed assistance by the Asian Development Bank, IRC:108.

Forecast future normal demand for transport by project road based on, but not necessarily limited to, annual population and real income per capita growth rates (in per cent per year) estimated in Road Influence Area (RIA), elasticity of transport demand in relation to income, and estimated annual production increases (in per cent per year) in RIA. In other words, annual traffic growth must be related to specific economic activity in each RIA. Transport demand should be projected on an annual basis over the project period. The formulae for annual growth (in per cent) of passenger vehicles and trucks may be assumed as follows:

a) Passenger Vehicles

Example: Assumptions

i) Population growth: 2.1 per cent a year during 1981-91 (expected population growth rates during 1991-2001, 2 percent per year)

ii) Real income per capita growth: 3.0 percent per year

Then,

Growth Rate (%) = [1 .020 x 1 .03 - 1] x 100 x E

	First Five Years	Second Five Years	Third Five Years
E for Cars, Jeeps and Vans	2.0	2.0	1.8
E for Buses	1.6	1.6	1.5
E for Two and Three wheelers	2.5	2.3	2.1

Where E is the elasticity of transport demand

b) Freight Traffic

Estimation of freight traffic is more complex in nature and involves the process of iteration as well as subjective decision so as to be compatible with the regional perspective plans and other indicators. The basic steps will comprise:

i) From socio-economic profile find out the annual weighted average growth rate in percent in the agricultural, industrial, mining and tourism sectors (assumed as the predominant sectors) from the State Domestic Product (SDP) database. This growth may be computed in five (5) year blocks;

ii) To the above growth rate, apply the elasticity of transport demand. For example For the first five years 2.0, second five years 1.8 and third five years 1.6;

Iii) Based on the above generate movement quantum in terms of commodity tonnage in the same block of years;

iv) Now assume percentage of likely market shares by LCV, HCV and MAV during the project period;

v) Further assign lead distance to connect the commodity movement into tonne-km and using step(iv) generate numbers of vehicles in blocks of five years;

vi) As a check back calculate the growth rates to examine its appropriateness in the context of regional development perspective and other development parameters. Apply suitable corrections, on subjective basis, to finalise the growth rates and generate annualised traffic streams in terms of LCV, HCV and MAV for use in pavement design as well as economic analysis.

1.5 Conclusion

From the findings of the alternative methods described, appropriate growth rates may be adopted for the project road concerned.

APPENDIX-3

POINTS ON WHICH DATA MAY BE COLLECTED DURING GROUND RECONNAISSANCE

1. Details of route vis-a-vis topography of the area, whether plain, rolling or hilly.
2. Length of the road along various alternatives.
3. Bridging requirements number, length.
4. Geometries Features:
   a) Gradient that are feasible, specifying the extent of deviations called for
   b) Curves hair-pain bends, etc.
   c) Railway crossings
   d) Ground constraints
5. Existing means of surface travel-mule path, jeep track, earthen cart tracks, rail way lines, waterway, etc.
6. Right-of-way available, bringing out constraints on account of built-up area, monuments, and other structures.
7. Terrain and soil conditions:
   7.1 Geology of the area
   7.2 Nature of soil, drainage conditions and nature of hill slopes
   7.3 Road length passing through
      i) Mountainous terrain
      ii) Steep terrain
      iii) Rocky stretches with indication of the length in loose rock stretches
      iv) Areas subject to avalanches and snow drifts
      v) Areas subjected to inundation and flooding
      vi) Areas subjected to sand dunes including location of dunes
      vii) Areas of poor soils and damage conditions
      viii) Areas with very poor sub-soil strength, e.g. marshes
      ix) Areas of high salinity or wet saline soil
   7.4 Cliffs and gorges.
   7.5 Drainage characteristics of the area including susceptibility to flooding
   7.6 General elevation of the road indicating maximum and minimum heights negotiated by mam ascents and descents in hill sections
   7.7 Total number of ascents and descents in hill sections
   7.8 Disposition and location of sand dunes
   7.9 Vegetation-extent and type

8. Climatic Condition

8.1 Temperature-monthly maximum and minimum readings

8.2 Rainfall data-average annual, peak intensities, monthly distribution (to the extent available)

8.3 Snowfall data-average annual, peak intensities, monthly distribution (to the extent available)

8.4 Wind direction and velocities

8.5 Visibility

8.6 Exposure to sun

8.7 Water Table and its variation between maximum and minimum

8.8 History of unusual weather, like, cloudbursts, etc.

9. Facilities Resources

9.1 Landing ground in case of hilly stretches

9.2 Dropping zones in case of hilly stretches

9.3 Foodstuff

9.4 Labour - local availability and need for import

9.5 Construction material timber, bamboo, sand, stones, shingle, etc. with extent of their availability, leads involved and availability of easy access

9.6 Availability of water, especially in arid zones

9.7 Availability of local contractors

10. Value of land-agriculture land, irrigated land, built-up land, forest land, etc.

11. Approximate construction cost of various alternatives

12. Access points indicating possibility of induction of equipment

13. Period required for construction

14. Strategic considerations

15. Recreational potential

16. Important villages, town and marketing centres connected

17. Economic factors:

i) Population served by the alignment

ii) Agricultural and economic potential of the area

iii) Marketing centres

18. Other major developmental projects being taken up in the area, e.g, railway project hydro-electric projects, railway projects, dams, reservoirs, mining/agricultural projects, etc.

19. Crossings with Railway Lines and other existing highways

20. Location of existing or proposed utilities along the alignment

21. Necessity of by-passes for towns and villages

22. Position of ancient monuments, burial grounds, cremation grounds, religious structures, hospitals and schools

23. Ecology and environmental factors

24. Aspects needing co-ordination with other administrative authorities

25. Traffic counts from existing records

APPENDIX-4

CHECKLIST OF MAJOR OPERATIONS INVOLOVED IN THE SURVEY AND INVESTIGATION FOR A ROAD PROJECT

1 Reconnaissance Survey (See Section 7)

i) Map Study
ii) Aerial Reconnaissance
iii) Ground Reconnaissance

2 Preliminary Survey (See Section 8)

i) Collection of general information about traffic, soil, subsoil and surface drainage, etc.,
ii) Establishment of reference bench marks
iii) Traverse survey
iv) Fly levels and Cross-Sections
v) Map preparation

3 Determination of Final Center Line in the Design Office (See Section 8)

4 Final Location Survey (See Section 11)

i) Staking of final centre line
ii) Referencing HIPs, POTs, etc.,
iii) Establishment of Permanent Bench Marks
iv) Longitudinal and Cross-Sections

5 Survey of Economic Profile

i) State's and road influence area's socio-economic profile
ii) Transport system in the State

6 Traffic Surveys (See Section 6)

i) Study of Data from Records
ii) Traffic counts, O-D Surveys, etc.,
iii) Traffic Projections
iv) Collection of Traffic Particulars for Railway Level Crossings and Road Junctions
v) Axle Load Surveys
vi) Analysis of Accident Records

7 Soil and Materials Surveys (See Section 12)

i) Study of available information
ii) Soil investigations for low embankments and demarcation of borrow areas
iii) Special investigations for high embankment

iv) Detailed investigations for flexible pavement/rigid pavement
v) Survey and evaluation of naturally occurring aggregates
vi) Manufactured aggregates/items
vii) Water for construction purposes

8 **Drainage Studies (See Section 14)**

i) HFL and ponded Water Level
ii) Depth of sub-soil Water Table
iii) Special investigations for cut sections and seepage glows
iv) Surface run-off

9 **Cross-drainage Structures (See Section 15)**

i) Site selection
ii) Collection of hydraulic and foundation data

RECOMMENDED MITIGATING MEASURES AND SUGGESTED GRADINGS FOR INITIAL ENVIRONMENTAL EXAMINATION (IEE)

ACTIONS AFFECTING ENVIRONMENTAL RESOURCES AND VALUES		RECOMMENDED FEASIBLE MITIGATING MEASURES	EE GRADING (SUGGE-STIVE)
a)	**Environmental Impacts Due to Project Location :**		
	i) Disruption to hydrology	May be avoided through planning measures	D2
	ii) Resettlement	Suitable compensation and resettlement planning require consideration	D1
	iii) Environmental aesthetics degradation	Care shall be taken to avoid/minimise effect	D2
	iv) Inequitable locations for rural roads	Cross roads suitably clubbed for access to the road. For the purpose, suitable connectors to be planned as part of project	D3
	v) Loss of terrestrial ecology including forests and wildlife	May be avoided through planning exercise or minimise the effect with mitigation measures	D2
	vi) Loss of aquatic ecology	May be avoided through planning exercise or minimise the effect with mitigation measures	D2
b)	**Impacts During Construction Phase :**		
	i) Site runoff from cut and fill area	Suitable measures to be adopted during construction	D1
	ii) Safety of works from accidents	All safety measures may be incorporated in tender document	D1
	iii) Slum creation hazards	Appropriate planning for housing of construction workers must be made	D1
	iv) Cultural differences hazards	Should preferably be avoided and public learning be made and considered	--
	v) Escape of hazardous materials	Strict monitoring of the movement of hazardous materials	D2
	vi) Escape of air pollution (including dusts)	Suitable measures will be adopted to prevent minimise	D1
	vii) Noise and vibrations	Effect shall be assessed and measures taken based on significant	D1

	ACTIONS AFFECTING ENVIRONMENTAL RESOURCES AND VALUES	RECOMMENDED FEASIBLE MITIGATING MEASURES	EE GRADING (SUGGE-STIVE)
	viii) Quarrying hazards (including use of explosives)	Appropriate planning operation of blasting and use of Operating Quarries	D3
	ix) Disruption of utilities along route	Shifting of utilities shall be planned in advance and provision kept in the project	D2
	x) Disruption of traffic along route	Judiciously planned to avoid/minimise disruption	D1
	ix) Disruption of utilities along route	Shifting of utilities shall be planned in advance and provision kept in the Project	D2
	x) Disruption of traffic along route	Judiciously planned to avoid/minimise disruption	D1
c)	**Impacts from Project Operations :**		
	i) Noise disturbances	Shall not go up from present level	D1
	ii) Vibration disturbances	appropriate planning and post-construction monitoring may be made	D1
	iii) Air pollution	appropriate planning and post construction monitoring may be made	D1
	iv) Continuing erosion	Protective vegetation and Other methods shall be adopted	D2
	v) Highway runoff contamination	Appropriate planning and post construction monitoring to take care	D2
	vi) Highway spills of hazardous materials	Appropriate spills control program and post construction monitoring to take care	D1
	vii) Escape of sanitary wastes	Appropriate planning/post-construction monitoring to be considered	D1
	viii) Congestion at access/exit points	Appropriate planning/post-construction monitoring be made to reduce eliminate the effect	D2
	ix) Inadequate highway maintenance	Post-construction monitoring is recommended	D3

Note: IEE grading Scale
D1 - Not Significant
D2 - Small significant effect
D3 - Moderate significant effect
D4 - Major significant effect

APPENDIX-6

CHECKLIST FOR A HIGHWAY PROJECT FEASIBILITY REPORT

General Details:
Project Name -
Consultant's Name -
Date of Review -

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
1	**Executive Summary**	Yes □ No □ NA □	NA	
2	**Overview of Client Organization/ Activities**	Yes □ No □ NA □	NA	
3	**Methodology Adopted for Feasibility Study**	Yes □ No □ NA □	NA	
4	**Socioeconomic Profile of the Project Areas**	Yes □ No □ NA □	NA	
4.1	Regional economic profile basis last 10 years data as per IRC	Yes □ No □ NA □	NA	
4.2	Economic profile of project influence area basis last 10 years data as per IRC	Yes □ No □ NA □	NA	
4.3	Socio Economic status of project influence area	Yes □ No □ NA □	NA	
5	**Indicative Design Standards, Methodologies, and Specifications**	Yes □ No □ NA □	NA	
6	**Traffic Surveys and Analysis**	Yes □ No □ NA □	NA	
6.1	Classified traffic volume counts using IHMCL data (7day data)	Yes □ No □ NA □	NA	
6.2	Traffic projection methodology as per IRC:108	Yes □ No □ NA □	NA	
6.3	Projected Traffic data for 20 years	Yes □ No □ NA □	NA	
6.4	Current and Projected PCU	Yes □ No □ NA □		
6.5	Current and Projected TVU	Yes □ No □ NA □		
6.6	Origin destination surveys as per IRC:102	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
6.7	Speed and delay studies as per IRC:102	Yes □ No □ NA □	NA	
6.8	Traffic surveys for the design of road junctions as per data in IRC:SP:41	Yes □ No □ NA □	NA	
6.9	Analysis for replacing railway level crossings with over bridges/ subways	Yes □ No □ NA □	NA	
6.10	Axle load survey	Yes □ No □ NA □	NA	
6.11	Any other details relevant to the project	Yes □ No □ NA □	NA	
6.12	Traffic surveys monitored and reviewed by the client	Yes □ No □ NA □	NA	
7	**Reconnaissance Survey**	Yes □ No □ NA □	NA	
7.1	Road Inventory Survey	Yes □ No □ NA □	NA	
7.2	Review of Road Inventory survey by client	Yes □ No □ NA □	NA	
7.3	Chainage wise details of pavement composition survey	Yes □ No □ NA □	NA	
7.4	Geological Survey • Geological Map of the Area • Seismicity	Yes □ No □ NA □	NA	
7.5	Climatic Conditions • Temperature • Rainfall • Wind	Yes □ No □ NA □	NA	
7.6	Pavement composition and condition survey	Yes □ No □ NA □	NA	
7.7	Review of pavement composition and condition survey by client	Yes □ No □ NA □	NA	
7.8	Pavement roughness survey as per IRC:SP:16	Yes □ No □ NA □	NA	
7.9	Review of pavement roughness survey by client	Yes □ No □ NA □	NA	
7.10	Pavement structural strength survey as per IRC:81	Yes □ No □ NA □	NA	
7.11	Review of pavement structural strength survey by client	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
7.12	Sub-grade characteristics and strengths	Yes □ No □ NA □	NA	
7.13	Topographical survey • Gradient • Terrain	Yes □ No □ NA □	NA	
7.14	Review of topographical survey by client	Yes □ No □ NA □	NA	
7.15	Inventory of bridges, culverts and structures	Yes □ No □ NA □	NA	
7.16	Condition survey for bridges, culverts and structures	Yes □ No □ NA □	NA	
7.17	Review of condition survey for bridges, culverts and structures by client	Yes □ No □ NA □	NA	
7.18	Any other details relevant to the project	Yes □ No □ NA □	NA	
8	**Geotechnical Survey**	Yes □ No □ NA □	NA	
8.1	Geo-technical and sub-soil explorations as per IRC:78	Yes □ No □ NA □	NA	
8.2	Bore holes dug for every pier and abutment	Yes □ No □ NA □	NA	
8.3	Review of geo-technical and sub-soil explorations by client	Yes □ No □ NA □	NA	
8.4	Field testing, soil sampling, laboratory testing in accordance with BIS/ AASHTO/ BS	Yes □ No □ NA □	NA	
8.5	Recommendation of Foundation Type and Depth	Yes □ No □ NA □	NA	
8.6	Any other details relevant to the project	Yes □ No □ NA □	NA	
9	**Hydraulic and Hydrological Survey**	Yes □ No □ NA □	NA	
9.1	Hydraulic and hydrological investigations as per IRC:SP:13 and IRC:5	Yes □ No □ NA □	NA	
9.2	High Flood Level specified	Yes □ No □ NA □	NA	
9.3	Depth of Water Table specified	Yes □ No □ NA □	NA	
9.4	Ponded Water Level specified	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
9.5	Any other details relevant to the project	Yes □ No □ NA □	NA	
9.6	Review of hydrological investigations by client	Yes □ No □ NA □	NA	
10	**Materials Survey**	Yes □ No □ NA □	NA	
10.1	Materials Survey conducted	Yes □ No □ NA □	NA	
10.2	Sources of Naturally Occurring Aggregates specified • Details of Borrow Pits with Distance from Project Site • Cost of Material/ Transportation	Yes □ No □ NA □		
10.3	Sources of Manufactured Items specified • Details of suppliers with distance from project site • Cost of material/ transportation	Yes □ No □ NA □	NA	
10.4	Sources of water for construction specified as per IS: 456	Yes □ No □ NA □	NA	
10.5	Any other details relevant to the project	Yes □ No □ NA □	NA	
11	**Environmental Screening/ Preliminary Environmental Assessment**	Yes □ No □ NA □	NA	
11.1	Analysis basis Initial Environment Examination	Yes □ No □ NA □	NA	
11.2	Recommended feasible mitigation measures	Yes □ No □ NA □	NA	
12	**Initial Social Assessment/ Preliminary LA Resettlement Plan**	Yes □ No □ NA □	NA	
12.1	Analysis basis Initial Environment Examination	Yes □ No □ NA □	NA	
12.2	Details of consultation with potentially affected persons	Yes □ No □ NA □	NA	
12.3	Names/ Details of consultation with local NGOs	Yes □ No □ NA □		
12.4	Names/ Details of consultation with municipal authorities	Yes □ No □ NA □		
12.5	Preliminary resettlement plan	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
12.6	Any other details relevant to the project	Yes □ No □ NA □	NA	
13	**Cost Estimates**	Yes □ No □ NA □	NA	
13.1	Item rates and rate analysis	Yes □ No □ NA □	NA	
13.2	Escalation	Yes □ No □ NA □	NA	
14	**Economic and Financial Analysis**	Yes □ No □ NA □	NA	
14.1	Estimated cost details	Yes □ No □ NA □	NA	
14.2	Projected revenues details	Yes □ No □ NA □	NA	
14.3	Assumptions stated	Yes □ No □ NA □	NA	
14.4	Analysis and results (IRR, Sensitivity Analysis, Financial Viability)	Yes □ No □ NA □	NA	
15	**Strip Plan and Alignment**	Yes □ No □ NA □	NA	
15.1	Details of center line of proposed highway	Yes □ No □ NA □	NA	
15.2	Details of existing RoW	Yes □ No □ NA □	NA	
15.3	Details of proposed RoW	Yes □ No □ NA □	NA	
15.4	Details about ownership of land to be acquired	Yes □ No □ NA □	NA	
15.5	Strip plan basis reconnaissance and topographic surveys	Yes □ No □ NA □	NA	
15.6	Strip plan reviewed and approved by the client	Yes □ No □ NA □	NA	
16	**Alignment Options Study**	Yes □ No □ NA □	NA	
16.1	At least two alignments proposed • Details of Alignments on Map	Yes □ No □ NA □	NA	
16.2	Review of options with client	Yes □ No □ NA □	NA	
16.2.1	Review of options with local authority	Yes □ No □ NA □	NA	
16.3	Length of the project along proposed alignment options	Yes □ No □ NA □		
16.4	Land Acquisition required along alignment options	Yes □ No □ NA □		
16.4.1	Environmental impact of each option	Yes □ No □ NA □		
16.4.2	Review of road geometry and safety for each option	Yes □ No □ NA □		

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
16.5	Cost Estimates of alternatives	Yes □ No □ NA □		
16.6	Recommended Alignment with Justification	Yes □ No □ NA □	NA	
16.7	Any other details relevant to the project	Yes □ No □ NA □	NA	
17	**Technical Specifications**	Yes □ No □ NA □	NA	
17.1	MoRTH technical Specifications for Roads and Bridge works followed	Yes □ No □ NA □	NA	
17.2	Details of technical specifications	Yes □ No □ NA □	NA	
18	**Rate Analysis**	Yes □ No □ NA □	NA	
18.1	Rate analysis for all relevant items as per latest SoR	Yes □ No □ NA □	NA	
19	**Cost Estimates**	Yes □ No □ NA □	NA	
19.1	Cost estimates for all relevant items as per latest SoR	Yes □ No □ NA □	NA	
20	**Bill of Quantities**	Yes □ No □ NA □	NA	
21	**Conclusions and Recommendations**	Yes □ No □ NA □	NA	
21.1	Conclusions and recommendations	Yes □ No □ NA □	NA	
21.2	Report fulfils project objectives and scope as per RFP	Yes □ No □ NA □	NA	
21.3	Report reviewed for errors and omissions	Yes □ No □ NA □	NA	
21.4	Compliance report prepared on client observations	Yes □ No □ NA □	NA	

SURVEY AND INVESTIGATIONS FORMATS

Inventory and Condition Survey for Bridges

FORMAT FOR INVENTORY AND CONDITION SURVEY OF BRIDGES																																			
Project Name:																																				
Sl. No.	Structure No.	Name of River Bridge	Chainage (Km)	Skew/Normal	Type	Span Arrangement	Total length of Bridge (C/C Exp Joints)(m)	Flow Direction	Width of Bridge (Inner to Inner Face of Railing or Parapet) (m)	Total Width (Outer to Outer face of Slab) (m)	Super structure		Parapet/ Railing/ Crash Barrier		Bearings		Expansion Joints		Substructure			Foundation		Return/Wing Walls			Bed Protection	Observations	Repair/Rehabilitation Measures	Remarks	General Condition	Recommendations
											Type	Condition	Type	Condition	Type	Condition	Type	Condition	Type	Height from GL (m)	Condition	Type	Condition	Type	Size	Condition							

Inventory and Condition Survey for Culverts

FORMAT FOR INVENTORY AND CONDITION SURVEY OF SLAB/BOX CULVERTS																					
Project Name:																					
Stru No.	Location (Km)	Type	Span Arrangement	Structure Details								Wing Wall/ Return Wall		Pitching	Parapet		Bed Protection	Remarks	Repair/Rehabilitation measures	Observations	General Condition	Recommendation
				Length (m)	Total width (O/O Parapet) (m)	Horizontal Vent width(m)	Opening Height (m)	Slab Thickness (m)	Abutment details	Road Level from Bed (m)	Flow direction	Details	Condition		Details	Condition						

FORMAT FOR INVENTORY AND CONDITION SURVEY OF HUME PIPE CULVERTS

Project Name:

Sl. No.										
Structure No										
Chainage (Km)										
Type										
Size (m)										
Total Width (Outer to Outer Parapet/ Head wall) (m)										
Flow direction										
Road Level from Bed level (m)										
Head Wall Type										
Head Wall Size	Length (m)									
	Thickness (m)									
Parapet	Length (m)									
	Thickness (m)									
	Height (m)									
Bed Protection & Revetment works										
General Condition and Observation										
Remarks										
Repair/Rehabilitation measures										
Recommendations										

FORMAT FOR ROAD AND PAVEMENT CONDITION SURVEY

Project Name:

Carriageway (Single/Dual)	Lanes 2 3 4 N/A	Side (Left/Right)

Stretch (km)		Pavement Condition							Embankment Condition			Drainage Condition		
From	To	Cracking			Ravelling %	Edge fretting (length in m)	Pot hole (%)	Rut Depth (mm)	General Condition	Slope Erosion	Failures	Height (m)	Connectivity E/NE/D	Stagnation E/NE	Culvert E/D
		Type	Narrow (<3mm) %	Wide (>3mm) %											

FORMAT FOR SHOULDER CONDITION SURVEY											
Project Name:											
Carriageway (Single/Dual)					LANES 2 3 4 N/A				Side (Left/Right)		
Stretch (km)		Paved Shoulder Condition							Earthen Shoulder Condition		
From	To	Cracking			Raveling %	Edge fretting (length in m)	Pot hole (%)	Rut Depth (mm)	Condition	Edge Drop (cm)	Material Loss/ Corrugations
		Type	Narrow (<3mm) %	Wide (>3mm) %							

FORMAT FOR ROAD AND PAVEMENT INVENTORY

Date:	Name of the Road:	Direction:	Weather:

Chainage (km)		Terrain	Land Use		Earthwork Type C/L/F		Surfacing Type	Carriage way Width (m)		Width of Median (m)	Shoulder				Road Side Drain				Soil Type & Colour
											Left		Right		LHS		RHS		
From	To		Left	Right	Left	Right		LHS	RHS		Type	Width (m)	Type	Width (m)	Type	Condition	Type	Condition	

FORMAT FOR CLASSIFIED VOLUME COUNT SURVEY OF PASSENGER TRAFFIC (1 HR.-15 MINS SLOTS)

Name of the Road :	Direction:	Survey Day :
Location :	Date of Survey:	Day:

Time Period	PASSENGER TRAFFIC									NON- MOTORISED TRAFFIC		
	2W	3W	Car/ Jeep	Car (Y.B)	Tata Magic	BUS						
						RTC Bus	Private Bus	Mini Bus	School Bus	Cycle	Cycle Rickshaw	Animal Drawn
Sub Total												
Sub Total												
Sub Total												
Sub Total												
Grand Total												

FORMAT FOR CLASSIFIED VOLUME COUNT SURVEY OF GOODS TRAFFIC (1 HR-15 MINS. SLOTS)

Name of the Road :	Direction:	Survey Day :
Location :	Date of Survey :	Day :

Time Period	GOODS TRAFFIC									GOVT EXEMPTED		
	TRUCKS				Tempo/ LCV	Mini LCV (Tata ACE)	Tractor	Tractor with Trailer	3W Goods	Cars	Mini Bus	Trucks
	2 Axle	3 Axle	Multi Axle	Heavy/ Earth Moving								
Sub Total												
Sub Total												
Sub Total												
Sub Total												
Grand Total												

FORMAT FOR PASSENGER ORIGIN DESTINATION SURVEY ROADSIDE INTERVIEW

Name of Road:	Direction : Towards	Date of Survey:
Location:	Survey Day:	Day:

S. No.	Vehicle Type	Vehicle No.	Origin		Destination		Distance (Km)	Purpose	Frequency
			Town/ Locality	District/ State	Town/ Locality	District/ State			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Vehicle Type	Purpose		Frequency
1. Car	1. Work	6.Recreation	1. Daily – D
2. Bus	2. Education	7.Health	2. Weekly – W
3. Mini Bus	3. Business	8.Returns	3. Monthly – M
4. Tata Magic	4. Social	9.Others	4. Yearly – Y
	5.Shopping		

FORMAT FOR GOODS ORIGIN DESTINATION SURVEY
ROADSIDE INTERVIEW

Name of Road:					Direction: Towards			Day of Survey:		
Location:					Day:			Sheet No :		
S. No.	Vehicle Type	Vehicle No.	Origin		Destination		Commodity Type	Distance (Km)	Frequency	National Permit (Yes/ No)
			Town/ Locality	District/ State	Town/ Locality	District/ State				
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

Vehicle Type	Frequency
(1) LCV	1. Daily – D
(2) 2 Axle Truck	2. Weekly –W
(3) 3 Axle Truck	3. Monthly – M
(4) MAV	4. Yearly – Y

FORMAT FOR PASSENGER ORIGIN DESTINATION SURVEY-NUMBER PLATE SURVEY

Name of Road:	Direction : Towards	Day of Survey:
Location:	Date of Survey:	Page No:

S. No	Time	Passenger Vehicles									
		Car		Car(Yellow Board)		RTC Bus & PVT Bus		Mini Bus		TATA MAGIC Passenger	
		State	No	State	No	State	No	State	No	State	No
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

FORMAT FOR GOODS ORIGIN DESTINATION SURVEY- NUMBER PLATE SURVEY

Name of Road:	Direction:Towards	Survey Day:
Location:	Date of Survey:	Page No:

S. No.	Time	Goods Vehicle									
		2 Axle Truck		3 Axle Truck		LCV		M Axle		Mini LCV	
		State	No	State	No	State	No	State	No	State	No
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

SPEED AND DELAY STUDY FORM NO.1

FORM FOR RECORDING THE TIME AT VARIOUS CONTROL POINTS

Name of Road _____ From _____ To_____

From Km:_____ to Km _____ No. of Trip_____

Date :_____

Time :_____

Sl . No.	Distance		Control Points	First Stop Watch		Second Stop Watch		Cause of Delay
				Journey Time		Delay Time		
	Km.	M.		Min.	Sec	Min.	Sec	

Name and Signature _____ Name and Signature _____

of Enumerators_____ of Supervisors _____ _____

SPEED AND DELAY STUDY FORM NO.2

FORM FOR NO. OF VEHICLES OVERTAKING THE TEST VEHICLES

Name of Road _____ From _____ To_____

From Km:_____ to Km _____ No. of Trip_____

Date :_____

Time :_____

FAST MOVING VEHICLES

Passenger Vehicles					Goods Vehicles		
Car/Jeep/Auto		Two Wheeler	Mini Bus	Bus	Tempo/LCV	Trucks	
New	Old					2 Axle	Multi Axle

Name and Signature _____ Name and Signature _____

of Enumerators_____ of Supervisors _____ _____

SPEED AND DELAY STUDY FORM NO. 3

FORM FOR NO. OF VEHICLES OVERTAKEN BY THE TEST VEHICLES

Name of Road _____ From _____ To_____

From Km:_____ to Km _____ No. of Trip_____

Date :_____

Time :_____

FAST MOVING VEHICLES

Passenger Vehicles					Goods Vehicles		
Car/Jeep/Auto		Two Wheeler	Mini Bus	Bus	Tempo/LCV	Trucks	
New	Old					2 Axle	Multi Axle

Name and Signature _____ Name and Signature _____

of Enumerators_____ of Supervisors _____ _____

SPEED AND DELAY STUDY FORM NO. 4

FORM FOR NO. OF VEHICLES TRAVELLING IN THE OPPOSITE DIRECTION

Name of Road _____ From _____ To_____

From Km:_____ to Km _____ No. of Trip_____

Date :_____

Time :_____

FAST MOVING VEHICLES

Passenger Vehicles					Goods Vehicles		
Car/Jeep/Auto		Two Wheeler	Mini Bus	Bus	Tempo/LCV	Trucks	
New	Old					2 Axle	Mini Axle

Name and Signature _____ Name and Signature _____

of Enumerators_____ of Supervisors _____ _____

AXLE LOAD SURVEY

Section :
Location:
Direction:

Date & Time :_____

Weather _____

FAST MOVING VEHICLES

Time	Vehicle Type	Origin	Destination	Commodity Type	Axle Load (Tonnes)						Remarks
					1st Axle	2nd Axle	3rd Axle	4th Axle	5th Axle	6th Axle	

Name and Signature _____ Name and Signature _____

of Enumerators_____ of Supervisors _____ _____

ROUGHNESS MEASUREMENTS USING BUMP INTEGRATOR

Chainage Km	Direction 1				Direction 2				
	Bump Reading BR	Wheel Revolution WR	Road Condition (Type of Surface Thickness, Drainage, etc.,)	UI cm/km A	Bump Reading BR	Wheel Revolution WR	Road Condition (Type of Surface Thickness, Drainage etc.,)	UI cm/km A	Mean Value (A+B) 2 cm/km

APPENDIX-8

ALIGNMENT OPTION STUDY

This appendix suggests a method of evaluation of the alignment alternatives against various aspects viz. engineering, socio-economic, environmental, cost and safety. Each aspect is sub-divided into various parameters of equal weightage i.e. 1 mark each. Details of each alignment is noted against each parameter, and the individual score is calculated for that parameter, by assigning 1 to the least value/best option, and proportionate value to the others.

The individual scores are then summarized for each aspect and the final score is calculated by applying the weightages given to each aspect as below, after considering relative importance and impact of each criteria. After evaluation of each alternative, the one which scores higher will be the preferred alternative.

a) Engineering Aspects : 25%
b) Socioeconomic Aspects : 20%
c) Environmental Aspects : 20%
d) Cost Aspects : 15%
e) Safety Aspects : 20%

An illustrative example of comparing 3 alternative alignments showing the above aspects, the suggested parameters under each aspect, is given below for better appreciation of the above procedure.

Evaluation of Alignment Options

S. No.	Description	Units	Maxi-Score	Alternative 1		Alternative 2		Alternative 3	
				Detail	Score	Detail	Score	Detail	Score
Engineering Aspects									
1	Physical location away from city	km	1	1.79	0.76	1.36	1.00	1.36	1.00
2	Terrain	-	1	Plain	1.00	Plain	1.00	Plain	1.00
3	Gradient	-	1	Flat	1.00	Flat	1.00	Flat	1.00
4	Proposed length of green field alignment/bypass/ realignment	km	1	7.5	0.77	5.8	1.00	7.9	0.73
5	Utilization of existing road by widening/ strengthening (1 mark for the highest)	km	1	0	0.00	0	0.00	0	0.00
6	Length of Service/slip Road	km	1	7.5	0.77	5.8	1.00	7.9	0.73
7	Horizontal curves	no	1	7	1.00	7	1.00	7	1.00
8	Number of Interchanges	no	1	1	1.00	1	1.00	1	1.00

S. No.	Description	Units	Maxi-Score	Alternative 1		Alternative 2		Alternative 3	
				Detail	Score	Detail	Score	Detail	Score
9	ROBs	no	1	0	0.00	0	0.00	0	0.00
10	VUPs	no	1	3	0.67	2	1.00	3	0.67
11	PUPs	no	1	2	1.00	2	1.00	2	1.00
12	MJBs	no	1	2	0.50	1	1.00	2	0.50
13	MIBs	no	1	4	1.00	4	1.00	5	0.80
	Subtotal		13		9.47		11.00		9.44
Socio-Economic Aspects									
1	Total land acquisition required	Hct.	1	45	0.91	41	1.00	53.6	0.76
2	Agriculture Land	%	1	100	0.90	90	1.00	100	0.90
3	Residential Land	%	1	0	1.00	10	0.00	0	1.00
4	Commercial Land	%	1	0	1.00	0	1.00	0	1.00
5	Industrial Land	%	1	0	1.00	0	1.00	0	1.00
6	Open/barren Land	%	1	0	1.00	0	1.00	0	1.00
7	Garden/Plantation Land	%	1	0	1.00	0	1.00	0	1.00
8	Forest Land	%	1	0	1.00	0	1.00	0	1.00
9	Recreational Development	%	1	0	1.00	0	1.00	0	1.00
10	Pond/Ditch/Water body	%	1	0	1.00	0	1.00	0	1.00
11	Demolition of small type houses	no	1	3	0.33	1	1.00	1	1.00
12	Demolition of important buildings/ houses	no	1	0	1.00	0	1.00	0	1.00
	Sub total		12		11.14		11		11.66
Environmental Aspects									
1	Alignment Length	km	1	7.5	0.77	5.8	1.00	7.9	0.73
2	Cross roads	no	1	10	0.60	6	1.00	8	0.75
3	Canal/river crossings	no	1	6	0.67	4	1.00	5	0.80
4	Use of Existing road	km	1	0	0.00	0	0.00	0	0.00
5	Damage of Agriculture land	%	1	100	0.90	90	1.00	100	0.90
6	Damage of residential and commercial land	%	1	0	1.00	10	0.00	0	1.00
7	Damage of Garden/ Plantation	%	1	0	1.00	0	1.00	0	1.00
8	Use of pond/Ditch/ Barren	%	1	0	1.00	0	1.00	0	1.00

S. No.	Description	Units	Maxi-Score	Alternative 1		Alternative 2		Alternative 3	
				Detail	Score	Detail	Score	Detail	Score
9	Length through Habitation	km	1	0	1.00	0	1.00	0	1.00
10	Presence of sensitive locations								
10.1	Reserve forest/ Protect forest/Breeding centre etc.	hct	1	0	1.00	0	1.00	0	1.00
10.2	School, College, Religious structures and Hospitals	no	1	0	1.00	0	1.00	0	1.00
	Subtotal		11		8.94		9		9.18
Cost Aspects									
1	Civil Cost (Rs Crores)	Rs.	1	150	0.77	116	1.00	158	0.73
2	Overall Cost including maintenance, LA etc. (Rs Crores)	Rs.	1	183	0.77	141.52	1.00	192.76	0.73
	Subtotal		2		1.55		2.00		1.47
Safety									
1	Road Geometry		1	Good	1.00	Good	1.00	Good	1.00
2	No. of Intersections	no	1	10	0.60	6.00	1.00	8.00	0.75
3	Road Safety		1	Safe	1.00	Safe	1.00	Safe	1.00
	Subtotal		3		2.6		3		2.75
Total Score			41		33.70		36		34.50
Final Summary									
1	Engineering Aspects				2.37		2.75		2.36
2	Socio-economic Aspects				2.23		2.20		2.33
3	Environmental Aspects				1.79		1.80		1.84
4	Cost Aspects				0.23		0.30		0.22
5	Safety Aspects				0.52		0.60		0.55
	Weighted Average Score				7.14		7.65		7.30
	Rank				3		1		2

Note: In the above example, alignment alternative 2 is the preferred option.

CHECKLIST OF ITEMS FOR DETAILED PROJECT REPORT FOR A HIGHWAY

General Details:
Project Name -
Consultant's Name -
Date of Review -

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
1	**Main Report**	Yes □ No □ NA □	NA	
2	**Introduction and Project Background**	Yes □ No □ NA □	NA	
2.1	Overview of project location, project objectives etc	Yes □ No □ NA □	NA	
2.2	Overview of report structure, deliverables etc.	Yes □ No □ NA □	NA	
3	**Social Analysis of the Project**	Yes □ No □ NA □	NA	
3.1	Project impact on stakeholders such as local people	Yes □ No □ NA □	NA	
3.2	Project impact on residential, commercial and public properties	Yes □ No □ NA □	NA	
3.3	Any other details relevant to the project	Yes □ No □ NA □	NA	
4	**Reconnaissance Survey**	Yes □ No □ NA □	NA	
4.1	Geometric Features of the Existing Road Design Speed • Sight distance details • Horizontal Alignment Details • Vertical Alignment Details • Height of Embankment	Yes □ No □ NA □		
4.2	Topographical Survey using LiDAR (or equivalent technology) • Gradient • Terrain	Yes □ No □ NA □	NA	
4.3	Pavement composition and condition survey	Yes □ No □ NA □	NA	
4.4	Pavement roughness survey as per IRC:SP:16	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
4.5	Pavement structural strength survey as per IRC:81	Yes □ No □ NA □	NA	
4.6	Geological Survey • Geological Map of the Area • Seismicity	Yes □ No □ NA □	NA	
4.7	Climatic Conditions • Temperature • Rainfall • Wind	Yes □ No □ NA □	NA	
4.8	Land Use along the existing alignment • Map of the Project Area depicting Agricultural/Habitation/Forest Area	Yes □ No □ NA □	NA	
4.9	Details of Existing Structures • Map of the Project Area depicting Hutments/Buildings/Temples/Public Building/Any Other Significant Structure	Yes □ No □ NA □	NA	
4.10	Inventory and condition survey of culverts	Yes □ No □ NA □	NA	
4.11	Geo-technical and sub-soil explorations as per IRC:78	Yes □ No □ NA □	NA	
4.12	Number of Bore holes dug (holes for every pier and abutment)	Yes □ No □ NA □		
4.13	Field testing, soil sampling, laboratory testing as per IRC: 78	Yes □ No □ NA □	NA	
4.14	Recommendation of Foundation Type and Depth	Yes □ No □ NA □		
4.15	Hydrological investigations as per IRC:5	Yes □ No □ NA □	NA	
4.16	High Flood Level specified	Yes □ No □ NA □	NA	
4.17	Depth of Water Table specified	Yes □ No □ NA □	NA	
4.18	Ponded Water Level specified	Yes □ No □ NA □	NA	
4.19	Materials Survey conducted	Yes □ No □ NA □	NA	
4.20	Sources of Naturally Occurring Aggregates specified • Details of Borrow Pits with Distance from Project Site • Cost of Material/Transportation	Yes □ No □ NA □		
4.20.1	Sources of environmentally friendly construction materials identified as per MoRT&H circular	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
4.21	Sources of Manufactured Items specified • Details of Suppliers with Distance from Project Site • Cost of Material/Transportation	Yes □ No □ NA □	NA	
4.22	Source of Water for construction specified as per IS:456	Yes □ No □ NA □	NA	
4.23	Any other details relevant to the project	Yes □ No □ NA □	NA	
5	**Traffic Studies and Demand Forecast Designs**	Yes □ No □ NA □	NA	
5.1	Classified traffic volume counts using IHMCL data (7 day data)	Yes □ No □ NA □	NA	
5.2	Traffic projection methodology as per IRC:108	Yes □ No □ NA □	NA	
5.3	Projected Traffic data	Yes □ No □ NA □	NA	
5.4	Current and Projected PCU	Yes □ No □ NA □		
5.5	Current and Projected TVU	Yes □ No □ NA □		
5.6	Origin destination surveys as per IRC:102	Yes □ No □ NA □	NA	
5.7	Speed and delay studies as per IRC:102	Yes □ No □ NA □	NA	
5.8	Traffic surveys for the design of road junctions as per data in IRC: SP:41	Yes □ No □ NA □	NA	
5.9	Analysis for replacing railway level crossings with over bridges/ subways	Yes □ No □ NA □	NA	
5.10	Axle load survey	Yes □ No □ NA □	NA	
5.11	Any other details relevant to the project	Yes □ No □ NA □	NA	
5.12	Traffic surveys monitored and reviewed by the client	Yes □ No □ NA □	NA	
6	**Cost Estimates**	Yes □ No □ NA □	NA	
6.1	Project costing as per latest SoR	Yes □ No □ NA □	NA	
7	**Environmental Aspects**	Yes □ No □ NA □	NA	
7.1	Environment profile of the project region	Yes □ No □ NA □	NA	
7.2	Details of Public consultation at residential and commercial settlements affected	Yes □ No □ NA □	NA	
7.3	Impact analysis and mitigation measures	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
8	**Economic and Commercial Analysis**	Yes □ No □ NA □	NA	
8.1	Estimated cost details	Yes □ No □ NA □	NA	
8.2	Projected revenues details	Yes □ No □ NA □	NA	
8.3	Assumptions stated	Yes □ No □ NA □	NA	
8.4	Analysis and results (IRR, Sensitivity Analysis, Financial Viability)	Yes □ No □ NA □	NA	
8.5	Conclusions and recommendations	Yes □ No □ NA □	NA	
8.6	Financial model shared with client and reviewed	Yes □ No □ NA □	NA	
9	**Conclusions and Recommendations**	Yes □ No □ NA □	NA	
9.1	Report fulfils project objectives and scope as per RFP	Yes □ No □ NA □	NA	
9.2	Report reviewed for errors and omissions	Yes □ No □ NA □	NA	
9.3	Compliance report prepared on client observations	Yes □ No □ NA □	NA	
10	**Design Report**	Yes □ No □ NA □	NA	
10.1	Highway improvement proposals	Yes □ No □ NA □	NA	
10.2	Highway geometric designs	Yes □ No □ NA □	NA	
10.3	Roadside drainage	Yes □ No □ NA □	NA	
10.4	Intersections	Yes □ No □ NA □	NA	
10.5	Urban service roads	Yes □ No □ NA □	NA	
10.6	Bus-stops	Yes □ No □ NA □	NA	
10.7	Toll plazas	Yes □ No □ NA □	NA	
10.8	Pedestrian crossings	Yes □ No □ NA □	NA	
10.9	Utility relocation	Yes □ No □ NA □	NA	
10.10	Pavement	Yes □ No □ NA □	NA	
10.11	Structures	Yes □ No □ NA □	NA	
10.12	Any other details relevant to the project	Yes □ No □ NA □	NA	
10.13	Pavement deflection survey as per IRC:81-1997	Yes □ No □ NA □	NA	
10.14	Any other details relevant to the project	Yes □ No □ NA □	NA	
11	**Materials Report**	Yes □ No □ NA □	NA	
11.1	Material investigations as per IRC:36-2010	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
11.2	Review of material investigations by client	Yes □ No □ NA □	NA	
11.3	Multiple borrow areas identified	Yes □ No □ NA □	NA	
11.4	Material survey	Yes □ No □ NA □	NA	
11.5	Review of material survey by client	Yes □ No □ NA □	NA	
11.6	Geo-technical and sub-soil explorations as per IRC:78	Yes □ No □ NA □	NA	
11.7	Review of geo-technical and sub-soil explorations by client	Yes □ No □ NA □	NA	
11.8	Field testing, soil sampling, laboratory testing in accordance with BIS/ AASHTO/BS	Yes □ No □ NA □	NA	
11.9	Pavement composition and condition survey	Yes □ No □ NA □	NA	
11.10	Review of pavement composition and condition survey by client	Yes □ No □ NA □	NA	
11.11	Pavement roughness survey as per IRC:SP:16	Yes □ No □ NA □	NA	
11.12	Review of pavement roughness survey by client	Yes □ No □ NA □	NA	
11.13	Pavement structural strength survey as per IRC:81	Yes □ No □ NA □	NA	
11.14	Review of pavement structural strength survey by client	Yes □ No □ NA □	NA	
11.15	Water sample tests as per MoRTH specifications	Yes □ No □ NA □	NA	
11.16	Any other details relevant to the project	Yes □ No □ NA □	NA	
12	**Environmental Assessment Report/ Resettlement and Rehabilitation Plan**	Yes □ No □ NA □	NA	
12.1	Option for alignment alternatives considered and conclusions	Yes □ No □ NA □	NA	
12.2	Land environment data collection and details/ impact/ mitigation measures	Yes □ No □ NA □	NA	
12.3	Air environment data collection and details/ impact/ mitigation measures	Yes □ No □ NA □	NA	
12.4	Water resources details/ impact/ mitigation measures	Yes □ No □ NA □	NA	

S. No.	SECTION OF THE REPORT	YES/NO/NA	Details/ Specifications	Remarks
12.5	Noise environment details/ impact/ mitigation measures	Yes □ No □ NA □	NA	
12.6	Biological environment details/ impact/ mitigation measures	Yes □ No □ NA □	NA	
12.7	Details of public consultation	Yes □ No □ NA □	NA	
12.8	Environment monitoring and management plan	Yes □ No □ NA □	NA	
12.9	Details of social impact assessment	Yes □ No □ NA □	NA	
12.10	Details of resettlement and rehabilitation action plan	Yes □ No □ NA □	NA	
12.11	Measures to minimize resettlement	Yes □ No □ NA □	NA	
12.12	Details of public consultation with stakeholders	Yes □ No □ NA □	NA	
12.13	Details of implementation arrangement/ budget	Yes □ No □ NA □	NA	
12.14	Any other details relevant to the project	Yes □ No □ NA □	NA	
13	**Technical Specifications**	Yes □ No □ NA □	NA	
13.1	MoRTH technical specifications for Roads and Bridge works followed	Yes □ No □ NA □	NA	
13.2	Details of technical specifications	Yes □ No □ NA □	NA	
14	**Rate Analysis**	Yes □ No □ NA □	NA	
14.1	Rate analysis for all relevant items as per latest SoR	Yes □ No □ NA □	NA	
15	**Cost Estimates**	Yes □ No □ NA □	NA	
15.1	Cost estimates for all relevant items as per latest SoR	Yes □ No □ NA □	NA	
16	**Bill of Quantities**	Yes □ No □ NA □	NA	
17	**Drawing Volume**	Yes □ No □ NA □	NA	
18	**Digital Drawings of Road**	Yes □ No □ NA □		
18.1	Highway cross sections	Yes □ No □ NA □		
18.2	3D engineered models of: • Road alignment geometry • Proposed highway • Proposed structures	Yes □ No □ NA □		

LIST OF LABORATORY TESTS TO BE CONDUCTED FOR HIGHWAY EMBANKMENTS

A. BOREHOLE SAMPLES

1. TESTS ON UNDISTURBED SAMPLES

Undisturbed samples are those collected in 100 mm dia thin-walled tubes conforming to IS:2132-1972. These should be tested in the laboratory for the determination of the following soil properties.

i) Grain Size Analysis (as per IS:2720 Part IV-1975)

ii) Natural moisture content (as per IS:2720 Part II-1973) and dry density

iii) LL & PL (as per IS:2720 Part V-1970)

(for soils suspected to be organic in nature, by virtue of colour, odour, texture, etc. LL on fresh as well as on oven-dry specimens may be separately found out)

iv) c_s, c_v and p_c (pre-consolidation pressure) from consolidation test (according to IS:2720 Part XV-1965)

v) c and Ø from unconsolidated, undrained (UU) triaxial test (according to IS:2720 Part XI-1971). Bulk density, void ratio and moisture content before/ after UU test should also be determined.

vi) Shrinkage limit-free swell and swelling pressure (particularly in case of black cotton soil) as per I.S.

2. TESTS ON SELECTED UNDISTURBED SAMPLES

Where the method of stage construction of embankment based on the effective stress method of design requires to be kept in view, selected and representative undisturbed samples should be further tested in the laboratory for the determination of the following soil properties:

c'/Ø' and A-factor from consolidated undrained triaxial tests with measurement of pore pressure i.e., C-U tests (according to IS:2720 Part XII-1981). Bulk density, void ratio and moisture content before/after C-U test should also be determined.

3. TEST ON DISTURBED SAMPLES

Samples from test pits must be tested for the following tests. Samples recovered from the SPT spoon should be retained in sealed air-tight glass jars. These samples may be treated as disturbed samples and should be tested in the laboratory for the determination of following soil properties:

i) Grain Size Analysis (according to IS:2720 Part IV-1975)

ii) Natural Moisture Content (as per IS:2720 Part II-1973)

iii) LL & PL (as per IS:2720 Part V-1970)

(For soils suspected to be organic in nature by virtue of colour, odour, texture, etc., LL on fresh as well as on oven-dry specimens may be separately found out).

B. ON FILL MATERIAL TO BE USED FOR FORMING HIGH EMBANKMENTS

Laboratory tests to be done

i) Grain Size Analysis (as per IS:2720 Part-IV-1975)

ii) Natural Moisture Content (as per IS:2720 Part-II-1973)

iii) LL & PL (as per IS:2720 Part-V-1970)

(For soils suspected to be organic in nature by virtue of colour, texture, odour, etc., LL on fresh as well as on oven-dry specimens may be separately found out)

iv) Moisture-density relation ship using light/heavy compaction, commonly known as Standard/modified proctor test (as per IS:2720 Part-VIII-1980)

On the basis of tests conducted as per (a) above, the samples may be categorised into types, each showing the same or closely similar soil characteristics. One or two samples out of each category may be judiciously selected so as to be representative and subjected to the following tests:

- For cohesive fill material (e.g. clay or silty/sandy clay mixed with silt/sand), c and Ø may be determined from unconsolidated undrained (UU) triaxial test (according to IS:2720 Part-XI-1972) on specimens remoulded to 95% proctor density at OMC plus 2%.
- If the fill material is cohesionless, Ø may be determined from direct shear test (according to IS:2720 Part-XIII-1972) on specimens remoulded to 95% proctor density at OMC.
- For cohesive fill materials which may be used for forming embankments likely to be subjected to submergence and drawdown, effective stress parameters c and Ø as also A-factor, may be determined from consolidated undrained test with measurement of pore pressure i.e. CU tests (according to IS:2720 Part-XII-1981) on specimens remoulded to 95% proctor density at OMC plus 2%. The test specimens in the triaxial cell need to be saturated by applying back pressure before shearing. This test will be in addition to that mentioned in (b) (i) above and may be carried out for selected few representative samples only.
- For any of the types of strength tests mentioned above, the actual bulk density, void ratio and moisture content of the specimens before/after the test should be found out and recorded.

SALIENT FEATURES OF THE MOEF & CC ENVIRONMENT GUIDELINES FOR HIGHWAY PROJECTS

A) Salient Features of the MOEF&CC Guidelines for Highway Projects

1) Purpose of Guidelines

- To assist the project authorities in planning and carrying out EIA and evolving Environmental Management Plan.
- These guidelines apply to both new projects and upgrading of existing facilities

2) Environmental Impact Assessment (EIA)

- EIA procedure identifies the possible positive and negative impacts resulting from a proposed project (**Table A-11.1**).
- For identification of impacts, **Table A-11.2**. provides as list of parameters relevant to transportation project including roads. The parameters are classified into four categories, viz., Natural physical resources, natural biological resource, human development resources and quality of life values including aesthetic and cultural values. See **Table A-11.3**. for questionnaire for environmental appraisal of project.

3) Environmental Impact Statement (EIS)

The EIS should cover

- Brief description of project
- Description of existing environment with in project influence area
- Likely impact; adverse and beneficial, reversible and irreversible
- Mitigation and conservation measures
- Consideration of alternatives including “no change option”
- Summary and conclusions

4) Environmental Management Plan (EMP)

It is implementation plan for mitigation and conservation measures recommended in the EIS. It may include several implementation plans. Each should include;

- Objective
- Work plan for Design criteria
- Implementation schedule
- Manpower requirements and
- Monitoring.

5) Identification of Impacts

Physical Resources

Impacts on hydrology, surface water quality, air quality, soils and noise impacts.

Ecological Resources

Impacts on Aquatic and Terrestrial ecosystems such as fisheries, forestry, wild life, etc..

Human use Values

Impacts on navigation, flood control, land-use and aesthetics

Quality of life Values

Impacts on socio-economic aspects, resettlement issues, public health, aesthetics, historical value.

6) Measures for Mitigation of Adverse Impacts

Careful attention be paid to site planning to minimise adverse impact to the extent possible. Protection measures may include establishment of forest reserve to minimise encroachment, fencing of road land, promoting new rural occupations.

Measures to deal with the various impacts are outlined as under:

i) **Air Quality:** Mobile source emissions.

- Construction during off-peak hours in heavy traffic areas
- Use of low emission construction vehicles
- Periodic check on all vehicles for emission control
- Use of lead free gasoline.
- Use of Electrical vehicles

ii) **Air Quality:** Fixed Source Emissions

- Stationary equipment to be located as far away as possible from the receptors
- Areas prone to dust emissions be sprinkled with water
- Dust covers over the beds of trucks
- Low emission equipment for construction

iii) **Noise:** Construction period

- Specify permissible standards of noise for construction equipment
- Specify maximum permissible noise levels for residential, commercial and institution areas seperately.
- Specify time restrictions for sensitive areas such as schools, hospitals
- Describe methods of enforcement for the above.

iv) **Noise:** Operation Phase

- ROW to have buffer strip on each side of road and where possible tree belts be planted
- Nose insulation including noise barries in certain areas such as schools/hospital
- Rerouting heavy traffic
- Changing speed limits

- Changing alignment

v) **Vibration**

- Appropriate construction technique to prevent damages due to vibration effects during construction

vi) **Relocation**

- Adequate time be given to relocate to alternative place
- Public relations through media
- Advance payment to relocatees
- Compensation for land property should be based on fair market value
- Reestablishment cost be carefully considered to off set the loss in income, increase in expenditure and relocatees may be offered replacement of living unit organised by the project authorities.
- Special low cost housing for squatters
- Set up special work sub-section to follow up the problems faced by the relocatees

7) Environmental Monitoring

i) **Air Monitoring**

Monitoring stations for air quality are recommended along the project road to compare with the background data parameter to be monitored are CO, HC, SO_2, NO_x and Pb. Frequency and duration of sampling may be sorted out with the concerned meteorological departments.

ii) **Noise Monitoring**

Monitoring stations be set-up in consultation with the Pollution Control Board of the Centre/State.

iii) **Water Quality Monitoring**

Monitoring of lead (Pb) content in the nearby water bodies and plants is recommended. Locations be determined in consultation with the Pollution Control Boards. Monitoring stations be set-up in consultation with the Pollution Control Board of the Centre/State.

8) Management Considerations

- Cut and fill technology
- Treatment of unstable areas
- Vegetative cover on slopes. Plant species in consultation with forest department
- Erosion control measures
- Careful attention to drainage needs
- Channel training and erosion control works of culverts
- Controlled blasting of rock
- Excavated material should not be dumped haphazardly
- Provision of adequate protective works
- Adequate provision of water supply, power and sanitation facilities.

- Fly-ash availability

Note: Vide MOEF letter No. J-21012/15/96-IA-III dated 12th March, 1997, the MOEF wrote to Secretary Ministry of Surface Transport regarding recommendations of the Working Graph constituted to consider issues relating to exemption from environmental clearance for road projects along existing alignments.

a) Recommendations are

i) Projects for improvement works along existing alignments with marginal land acquisition be exempted from environmental clearance.

ii) Cases involving acquisition of marginal land would be examined by the concerned Ministry and approval accorded at their end, keeping in view the following:

a) No problems envisaged where land is in possession of the department

b) No problems envisaged where extra barren land is to be acquired

c) Adequate compensating plantation necessary where acquisition of additional land involves cutting of trees

d) Where acquisition of additional land involve, displacement of locals

iii) Where diversion of forest land is involved, clearance would be required under the forest (conservation) Act 1980

iv) Where diversion of land from wildlife sanctuaries or National Parks or Protected area is involved, clearance would be required under the wildlife (Protection) Act 1972

v) It is necessary for project proponents to carry out EIA study and provide mitigation measures

vi) Environmental Clearance is a per-requisite for all Green Field roads

vii) MOEF & CC would be kept apprised of any developmental projects being implemented.

b) Coastal Regulation Zone

Coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) upto 500 meters from the High Tide Level (HTL) and the land between the Low Tide Level and the HTL is declared as Coastal Regulation Zone.

Construction activities are prohibited in the Coastal Regulation Zone except for existing roads or those specifically approved in the Coastal Zone Management Plan of the area categorised as CRZ II, viz., the areas that have already been developed upto or close to the shore line and provided inter-alia with approach road.

Table A-11.1

Beneficial and Negative Impacts of Highway Projects

BENEFICIAL IMPACTS	NEGATIVE IMPACTS
Employment opportunity to people	Erosion and sediment discharge.
Enhancement of local industry, agriculture and handicrafts	Poor drainage resulting in rail/road/highway damage and leading to flooding problems and degradation of water resources. Formation of new gullies.
Income from visitors and taxes	
Enhancement of rural development through quick and easy transportation of building materials	Increase in concentration of runoff causing surface water pollution and soil pollution.
Transporting, processing and marketing of agricultural products.	Clearing of roadside vegetation for fire-wood, grazing, cultivation and urbanisation.
Opening up of opportunities for new occupations.	Increase in traffic litter, noise and dust pollution.
Approach to quick services and safety.	Air quality affected by vehicular exhausts; smoke with reference to SPM, NOx, CO, HC and lead.
Improved quality of life for people and so on.	Spell of toxic and hazardous chemicals from the carriers using the highway for transportation of such material. Transfer of vector diseases.
	Effect on wildlife through habitat loss and encroachment.

Table A-11.2

Some Environmental Parameters Associated with Transportation Sector Projects

Developmental Projects	Environmental Parameters
Highway	Surface water quality
	Air Quality
	Siesmology/Geology
	Erosion
	Land Quality
	Fisheries
	Aquatic wildlife
	Forests

Developmental	Environmental
	Terrestrial Wildlife
	Noise
	Land use
	Aesthetics
	Industries
	Resettlement
	Archaeological/Historic
	Significance
	Public Health
	Socio-Economic

B) Cost of Environmental Protection Measures (Rs. Lakhs)

S No.		Recurring Cost per annum	Capital Cost
1	Pollution Control		
2	Pollution Monitoring		
3	Solid Waste Management		
4	Green Belt		
5	Others (Please Specify)		
Total			

Table A-11.3

Questionnaire for Environmental Appraisal
(For Road/Highway Projects)

Note 1 :	All information given in the form of annexures should be part of this file itself. Annexures as separate files will not be accepted.
Note 2 :	Please enter x is a appropriate box where answer is Yes/No.

I) General Information

A) Name of the Project
B) Length (in kilometers)
C) Location

Stretch of Road/ Alignment	Village	Tehsil	District	State

D) Geographical Information

1) Latitude From [ ] To [ ]

2) Longitude From [ ] To [ ]

3) G.T. Sheet No. (Survey of India Map No.).

4) Elevation above Mean Seal Level (metres)

Min. [ ] Max. [ ]

5) Total Area proposed for the Project (in ha.) [ ]

6) Nature of Terrian

7) Nature of Soil
(Clayey, Sandy, Silty, Loam, etc.) [ ]

8) Permeability along the route in various Sections [ ]

II) Current land use of the proposed project site area (in ha.)

A)	Agricultural	
	1) Irrigated	[ ]
	2) Unirrigated	[ ]
B)	Homestead	[ ]
C)	Forest	[ ]
D)	Notified Industrial Area/Estate	[ ]
E)	Grazing	[ ]
F)	Fallow	[ ]
G)	Mangroves	[ ]
H)	Orchards	[ ]
I)	Sand Dunes	[ ]
J)	No Development Zone	[ ]
K)	Marshes	[ ]
L)	National Park/Sanctuary	[ ]
	Total	[ ]

III) Alternate Routes/Alignments Considered

A) _____

B) _____

C) _____

D) _____

IV) Reason for selecting the proposed Route/Alignment :

V) Land use plan

A) Does the proposed project confirm to the approved land use all along the route/ alignment ? (To be certified by the concerned Department of State Government).

Yes ☐ No ☐

B) If not, clearly indicated, which of the stretches are not as per approved land use

C) Does it confirm to the Regional Development Plan ?

Yes ☐ No ☐

VI) Site Preparation

A) Is the proposed route/alignment located in low-lying area ?

Yes ☐ No ☐

B) Level before fillling (above MSL in m)

C) Level after filling (above MSL in m)

D) Details of fill material required

Quantity of Fill Material required (in cu.m)	Source

E) Gradient details

F) Would be above filling result in complete/partial filling of water Bodies ?

G) Does the site involve stripping ?

Yes ☐ No ☐

If yes, provide the following details :

1) Size of the area to be stripped.
2) Location
3) Soil Type
4) Volume and quantity of earth to be removed.
5) Location of dump site

6) Proposal for utilisation of removed top soil.

H) Does it involve cutting ?

Yes ☐ No ☐

If yes, please furnish the following details :

1) Size of the area to be cut
2) Depth of cut
3) Location
4) Soil Type
5) Volume and quantity of earth and other material to be removed.
6) Location of dump site.

I) Does it involve tunnelling ?

Yes ☐ No ☐

If yes, please furnish the following details :

1) Lithology
2) Geological structural fraction
3) Diameter (meters)
4) Length (kilometer)
5) Location

J) Does the site preparation require cutting of trees ?

Yes ☐ No ☐

If yes, please furnish the following details:

1) How many trees are proposed to be cut ?
2) Species of the above trees
3) Are there any protected/endangered species ?

Yes ☐ No ☐

If yes, provide details

VII) In case the route/alignment falls totally or partially in the CRZ area

A) What is the categorization of the area (as per approved CZMP) ?

CRZ-IA ☐
CRZ-IB ☐
CRZ-II ☐
CRZ-IIIA ☐
CRZ-IIIB ☐
CRZ-IVA ☐
CRZ-IVB ☐

B) Does the proposed activity quality under the category of permissible activity ?

Yes ☐ No ☐

C) If yes, under what provision is it permitted ?

Sl. No	Provision No.

D) In case the road passes through a flood plain of a river, please furnish :

1) Detailed micro-drainage
2) Flood passages
3) Flood periodicity in the area

E) Does the proposed project involve construction of any sandy stretch ?

Yes ☐ No ☐

If yes, please funish detail

F) Height (above MSL in metres) ☐

G) Does the project involve extraction of sand, leveling or digging of sandy stretches within 500 mts. Of the high tide line ?

Yes ☐ No ☐

If yes, mention the activity involved and area.

1) Stetch ☐
2) Area (sq. metres) ☐

H) Does the project involve any dredging ?

Yes ☐ No ☐

If yes, please provide the following details (capital/maintenance)
Extent of dredging, disposal of dredged material etc.

I) Is any sand proposed to be removed from sand dunes ?

Yes ☐ No ☐

J) Does the project involve cutting/destroying of mangroves ?

Yes ☐ No ☐

If yes, give detail

1) Area
2) Species
3) Existing health

VIII) Details of the location :

	Sea	Other Water Bodies River/Creek/Lake, etc. (Please specify)
Distance seaward boundary from the edge of the alignment (in m.)		
Distance of seaward boundary of construction (in m.)		

IX) Does the proposed project site involve any breeding or nesting ground ?

Yes ☐ No ☐

If yes, provide the following details

A) Name of the aquatic organism
B) Type of habitat
C) Period of year in which activity takes place
D) Independent report of biohabitat study may be furnished.

X) **Does the project have any adverse effect on biodiversity ?**
If so, details of flora and fauna so affected.

XI) **Does the project involve any land reclamation ?**

Yes ☐ No ☐

If yes, please provide the following details

A) Activity for which land to the reclaimed ☐

B) Area of land to be reclaimed (Hectares) ☐

XII) **Whether there will be any change in the drainage pattern after the proposed activity ?**

Yes ☐ No ☐

If yes, what are the changes ?

A) What is the maximum extent ☐

B) Is any additional area to be flooded ☐

XIII) **Does the proposed alignment/route involve migratory path of animals ?**

Yes ☐ No ☐

If yes, please provide the following :

A) Name of fauna

B) Habitat

C) Period of the year in which activity take place

XIV) **Project Details (A summary of project proposal shall be enclosed).**

A) Length of New alignment proposed (kms) ☐

B) Width of the new alignment (meters) ☐

C) Length of existing alignment proposed to be Strengthened/widened (kilometres) ☐

D) Width of the existing alignment (metres) ☐

E) Width of the existing alignment after widening (metres) ☐

F) Total Length of the alignment (kilometres) ☐

G)	No. of Bridges	Major	
		Minor	
H)	Length of Bridges (metres)		
I)	Width of Bridges (metres)		
J)	No.of Culverts		
K)	Length of Culverts (metres)		
L)	Number and distance (metres) between underpasses		
M)	No.of intersection		
N)	Length of Intersection (metres)		
O)	No.of Railway crossings		
P)	Length of Railway crossings (metres)		
Q)	No.of Villages through which alignment passes through		
R)	Population of the Villages		

XV) Raw material required during construction

S.No	Item	Quantity (Tonnes)	Mode of Transport	Source
1	Stonemetal			
2	Bricks			
3	Sand			
4	Cement			
5	Bitumen			
6	Diesel			
7	Others (Please specify)			

XVI) Water required during construction:

A) Water Requirement (cu.m./day)

S. No	Purpose	Average Demand	Peak Demand	Source	Type Treated/ Untreated/ Fresh/ Recycled	Remarks
1	Road making					
2	Dust Suppression					
3	Drinking					
4	Others (Please specify)					
	TOTAL					

B) Source of Raw Water Supply (Net)

S.No	Source	Cu.m/hr	Cu.m/day
1	Sea		
2	River		
3	Groundwater		
4	Rainwater harvesting		
5	Municipal water supply		
6	Others (Please specify)		

XVII) Whether there will be any ingress of saline water into ground water due to project ?

Yes ☐ No ☐

XVIII) Whether any of the following exist within 10km of the project site. If so please indicate aerial and the name of the site.

S.No.	Item	Name	Aerial Distance (in Km)
1	National Park		
2	Marine Park		
3	Sanctuary/Tiger Reserve/Elephant Reserve/Turtle nesting ground		
4	Core Zone of Biosphere Reserve		
5	Reserved Forest		
6	Wildlife Habitat		
7	Habitat of endangered/exotic species		
8	Coral Reef		
9	Mangroves		
10	Lakes/Reservoirs/Dams		
11	Breeding Site		
12	Nesting Site		

XIX) Ambient Air Quality (for RPM, SPM, SO_2, NO_x, CO)

Procedures adopted should be as per guidelines of CPCB and should cover one full season (Locations should be so selected to represent the varying geographical locations and sensitive receptors)

S.No	Stretch of the Road	Date, Time & Location	Concentration as monitored (in ug/m^3) SPM, SO_2, NO_x, CO	Permissible Standard (As per SPCB guidelines)	Remarks (Name of the instrument and sensitivity)

XX) Solid Waste

A) Solid Waste generated during Road Construction (Tonnes/day)

1)	Top Soil	
2)	Overburden	
3)	Others (Please Specify)	
	Total	

B) Possible users of solid waste

C) Method of disposal of solid waste

Method

1) Landfill

2) Others (Please specify)

3) In case of landfill

a) Is solid suitable for landfill Yes No

b) Dimensions

c) Life of landfill

d) Proposed precautionary and mitigation measures

e) Other alternative proposed along with details

XXI) Noise level (dB)

S. No	Stretch of the Road (Locations should be so selected to represent the varying geographical locations and sensitive receptors)	Noise before Construction	Noise after Construction	Abatement Measures
1				
2				
3				

XXII) Projected Air Quality (taking into account the traffic projections on this road).

(SPM, SO_2, NO_x, CO in ug/m^3)

S.No	Pollutant	Before Constructions	After Constructions
1	SPM		
2	SO_2		
3	NO_x		
4	CO		

XXIII) Storage (of inflammable/explosive/hazardous/toxic substances)

S. No	Name	Consumption (in TPD)	Maximum Quantity at any point of time (tonnes)	Means of Transportation
1	Bitumen			
2	Diesel			
3	Others (please specify)			

XXIV) Occupational Health

A) What are the major occupational health hazards and hazards anticipated due to use of explosive, if any and safety measures to be adopted?

B) What provision have been made/proposed to be made to conform to health/ safety requirements ?

C) Details of personal protective equipment provided/to be provided to the workers

XXV) Green Belt

A) Total area of project (in ha.) [ ]

B) Area already afforested (for existing projects), in ha. [ ]

C) Area proposed to be afforested (in ha.) [ ]

D) Width of green belt (minimum, in m.) along the alignment [ ]

E) Trees planted and proposed [ ]

Nos.

1) Planted [ ]

2) Proposed [ ]

3) List of species [ ]

F) Proposal for maintenance of plantation [ ]

XXVI) Construction Phase

A) Estimated duration of construction

B) Number of persons to be employed for construction

1) Peak

2) Average

C) Proposal for employment of local people

D) What provisions has been made for the sanitation for the construction workers ?

E) How the fuel (kerosene/wood, etc.) requirement of labour force will be met to avoid cutting of trees from the adjoining areas.

F) Measures for Health care will emphases on protection from endemic diseases.

XXVII) Socio-economic profile

A) Human Settlement

	Aerial distance from the periphery of the site		
	Upto 500 m From the Periphery	500 m to 3000 m From the Periphery	3000 m to 7000 m From the Periphery
Population			
Of which			
SC/ST			
Number of Houses			
Present Occupational Pattern			

B) Economic Activity

S. No	Population	Occupation (Agriculture/ Horticulture/Fishing/Tourism/ Transport/Construction)	Average Income per annum

XXVIII) Rehabilitation & Resettlement Plan including vocational training and other avenues of employment

A) Population to be displaced

S.No	Name of Village	Population		Land + Homestead Oustees
1		Land oustees only	Homestead Oustees only	
2				
3				

B) Rehabilitation Plan for Oustees

C) Site where the people are proposed to be resettled

D) Compensation package

E) Agency/Authority responsible for their resettlement

XXIX) Does it involve displacement of ethnic minority

Yes ☐ No ☐

If yes, please furnish details

S.No	Name of the Community	Number of Males	Number of Females	Total

A) Please specify any special measures for their rehabilitation.

XXX) Pollution Control

A) Details of Pollution Control Measures/Environmental Safeguards:

S.No	Existing	Proposed to be installed
1	Air	
2	Water	
3	Noise	
4	Solid Waste	

B) Protection of Forest/National Park/Sanctuary/Mangroves

1	Agricultural Land	
2	Grazing Land	
3	Top Soil	
4	Natural Resources	
5	Sand dunes and mudflats	
6	Hill feature	
7	Reclaiming borrow area	
8	Low-lying area	
9	Soil and slope stablization	
10	Preventing siltation	
11	Archaeological and other Heritage sites	

XXXI) Expenditure Environmental Measures :

A) Capital cost of project (as proposed to the funding agency/financial institutions)

(Rs. Lakhs) ☐

XXXII) Public Hearing

A) Date of Advertisement

B) Newspapers in which the advertisement appeared

C) Date of Hearing

D) Panel Present

E) List of Public present along with addresses and occupation

S No.	Summary/Details of Public hearing Issues raised	Recommendation of Panel	Response of Project Proponents
1			
2			
3			
4			

The data and information given in this Performa are true to the best of my knowledge and belief

Date:

Signature of the Applicant with
Full Name & Address.

Place:

Given under the Seal of Organisation on behalf of whom the Applicant is Signing.

INTRODUCTION OF CENTRALIZED ROAD DATA BANK

1) Introduction

The advent of personal computers has made it possible to establish road data banks, which can be used both for macro and micro level administration of various road networks.

As far as possible all project preparation work shall be made computer oriented and the basic steps starting from collection of data on Road Inventory, condition survey etc. shall be formulated with due consideration to the requirement of computer-based Road Data Bank (RDB).

2) Reference System

The important element in establishment of an RDB is the choice of reference system. The reference system for the National and State Highways may be the kilometer posts. For secondary road system the same may be tied to the NH and SH road networks. Hence, prior to collection of data the reference system has to be determined to suit the application of data for easy storage and retrieval.

Alternately, the road network can be referenced with Global Positioning System. All along the road network, the agencies preparing the DPR or constructing the road or carrying out the O&M activities, can be mandated to establish permanent primary control points of larger standard dimensions, (Refer Para 8.2.4 of this Manual) using high accuracy DGPS equipment. MORTH and NHAI may also take up this activity through a centralized agency so that the accuracy can be consistent.

3) Different Data Types

A lot of data is captured during various types of surveys using new technology viz., Network Survey Vehicle, Terrestrial/Mobile/Aerial LiDAR, FWD, GPR, Drone based bridge inspection, photogrammetry, thermal cameras etc. This data may be pertaining to inventory and condition of road assets. The data capturing should facilitate linking with GPS based reference system of equal accuracy. One should be able to retrieve the data pertaining to a specific location or reach and locate the asset or a specific defect in the field, which is identified during the analysis. This will be only possible with GPS based recording and retrieval system.

The data generated can be utilized for asset management, operation and maintenance of the assets. The O&M agencies collect this data at predetermined intervals, which can be analyzed using machine learning tools and deterioration models can be formulated for prediction of distress and prescription of maintenance measures.

Similarly, the designs and drawings of the project assets can be stored in the data base by properly linking with the GPS system. The assets can also be mapped with suitable information models so that any changes in the designs and drawings can be affected easily on the project model.

Data pertaining to sub-soil investigations, material investigations, estimation and costing, land acquisition, utility reallocation etc., Traffic Data, WIM/Load Data, Toll Data, Accident Records, History of Construction and Maintenance/overlays etc. can also be stored in a GIS based data base management system. While doing the project preparation, data collection should be made in such manner that it is possible to link all the data to the central database.

STANDARD OPERATING PROCEDURES INVESTIGATIONS USING MODERN TECHNOLOGY

A) Standard Operating Procedure to Carry out Topographical Survey with Aerial Photogrammetry

i) Purpose

To collect the quality ortho images and point data quickly in order to generate three dimensional models and topographic map in minimum time period using Aerial Photogrammetry for the Green Field/Existing Alignments

ii) Definition/Abbreviation

The word "photogrammetry" is composed of the words "photo" and "meter" which means measurements from photographs.

UAV : Unmanned Aerial Vehicle
GNSS : Global Navigation Satellite System
DGPS : Differential Global Positioning System
TBM : Temporary Benchmark
RTK : Real Time Kinematic
IMU : Inertial Measurement Unit
GCS : Ground Control Station (Computer)
GTS : Great Trigonometric Survey
GSD : Ground Sampling Distance
GCP : Ground Control Point
RMS : Root Mean Square

iii) Procedure

- Establish the DGPS pillars at every 5 km, and TBM pillars at every 250 m.
- Mark the Ground Control Points (GCPs) on the ground in the survey corridor, at a close interval
- Carry the Level to each pillar from GTS Benchmark with Digital/Auto Level.
- Connect all the GCPs by running traverse with RTK/Total Station.
- Attach visual camera to UAV.
- Place the UAV at take-off site.
- Power on the UAV and Remote Controller.
- Calibrate UAV compass, IMU and visual sensors.
- Load the required mapping corridor plan into GCS application.
- Draw a flight plan in GCS application.
- Set the flying height, GSD, camera view and overlap.
- Check the flying parameters.

- Take-off the UAV in autonomous mode.
- Verify the capturing in real time.
- Land the UAV in autonomous mode.
- Copy/download the captured ortho view images.
- Load the captured images and Ground Control Points into Processing software.
- Input the GCP value to the marking in the image.
- Generate key points and tie points.
- Check the RMS error values in the quality report.
- Generate Point cloud and Orthomosaic.
- Verify the point cloud with Ground Control Points.
- Digitize/ Extract all existing features on Orthomosaic.
- Classify the ground points from point cloud.
- Remove the noise from point cloud.
- Drape the features on the surface to get three dimensional output.
- Prepare the base map with all topographic features.

iv) Precautions

- Ensure that all propellers are tightly fixed.
- Check the UAV hardware, battery and flight parameters before commencement of take-off.
- Avoid flying in low light condition, high temperature and wind speed.
- In order to get accurate output, mark the GCPs at closure interval.

B) Standard Operating Procedure to Carry out Topographical Survey with Aerial LiDAR on UAV

i) Purpose

To collect the quality point data quickly and accurately in order to generate precise three dimensional models and topographic map in minimum time period in green field projects.

ii) Definition/Abbreviation

LiDAR is a remote sensing method used to measure the distance of an object on the earth surface by emitting laser light on the target. The differences in laser return times and wavelengths, gives precise data to generate three dimensional digital point cloud of the target

LiDAR : Light Detection and Ranging
UAV : Unmanned Aerial Vehicle
GNSS : Global Navigation Satellite System
DGPS : Differential Global Positioning System
TBM : Temporary Benchmark
RTK : Real Time Kinematic

IMU : Inertial Measurement Unit
GCS : Ground Control Station (Computer)
GTS : Great Trigonometric Survey

iii) Procedure

- Establish DGPS pillars at every 5 km and TBM pillars at every 250 m.
- Mark the check points on the ground at specific interval.
- Connect all the check points with RTK DGPS.
- Carry the Level to each pillar from GTS Benchmark with Digital/Auto level.
- Start the base/ reference station observation on DGPS pillars
- Place the UAV at take off site.
- Attach visual camera to LiDAR Setup.
- Mount the LiDAR setup to UAV.
- Power up the LiDAR system.
- Power up the Wi-fi antenna and connect the cable to GCS.
- Connect the GCS to LiDAR system through Wi-fi.
- Turn on the LiDAR sensor.
- Initiate UAV take off and hover at comfortable height.
- Calibrate the GNSS/IMU by making figure-8 patterns manually.
- Check the uncertainties in GCS.
- Give predefined flight path to UAV.
- Start the LiDAR and Camera data acquisition
- Finish the Acquisition over given corridor.
- Stop both LiDAR and Camera acquisition.
- Conduct figure-8 patterns at comfortable height.
- Land the UAV and keep it in static condition for 5-10 minutes.
- Download the data and turnoff the sensors.
- Detach the LiDAR and Camera from UAV.
- Post process the trajectory with known base station values
- Fuse the colour from images to point cloud.
- Export the point cloud.
- Check the quality with RTK data.
- Classify the ground data from point cloud.
- Remove the noise from point cloud
- Extract/Digitize the features
- Prepare the base map with all topographical features.

iv) Precautions

- Calibration of GNSS/IMU should be done in clear sky view location.
- Check the uncertainties in GCS during the acquisition.

- Flight path should be prepared by considering flying altitude, LiDAR overlap and Image overlap.
- Flying straight direction is recommended to obtain smooth scan lines throughout the scan area.
- Avoid sharp turns and extreme elevation changes and turn only at the perimeter of scan area, Using of autopilot is preferred for getting best scan results.
- Make sure of logging rate that both Reference (Base) station and rover are same.

C) Standard Operating Procedure to Carry out Topographical Survey with Mobile LiDAR

i) Purpose

To collect the quality point data quickly and accurately in order to generate precise three dimensional models and topographic map in minimum time period along the existing Highway Alignment.

ii) Definition/Abbreviation

LiDAR is a remote sensing method used to measure the distance of an object on the earth surface by emitting laser light on the target. The differences in laser return times and wavelengths gives the precise data to generate digital three dimensional point cloud of the target.

LiDAR : Light Detection and Ranging
GNSS : Global Navigation Satellite System
DGPS : Differential Global Positioning System
TBM : Temporary Benchmark
RTK : Real Time Kinematic
IMU : Inertial Measurement Unit
GCS : Ground Control Station (Computer)
GTS : Great Trigonometric Survey

iii) Procedure

- Establish the DGPS pillars at every 5 km and TBM pillars at every 250 m.
- Mark the traverse points on the ground.
- Carry the Level to each pillar from GTS Benchmark with Digital/Auto Level.
- Connect all the traverse points with RTK/Total Station.
- Start the base/reference station observation on DGPS pillars
- Install the Camera on vehicle
- Fix the LiDAR to the vehicle and place the GNSS antenna
- Connect the output cables to GCS.
- Power up the LiDAR and the Camera.
- Turn on the LiDAR sensor.
- Calibrate the GNSS/IMU by making circular motions.

- Check the uncertainties in GCS.
- Start the LiDAR and Camera acquisition.
- Finish the Acquisition along required stretch.
- Stop both LiDAR and Camera acquisition.
- Conduct circular motions and keep vehicle in static condition about 5 minutes.
- Download the data and turnoff the sensors.
- Detach the Camera, LiDAR, Antenna and Cables.
- Post process the trajectory with known base station values
- Export the point cloud.
- Check the quality with RTK data.
- Classify the ground data from point cloud.
- Remove the noise from point cloud
- Extract/Digitize the features
- Prepare the base map with all topographical features.

iv) Precautions

- Calibration of GNSS/IMU should be done in clear sky view location.
- Check the uncertainties in GCS during the acquisition.
- Ensure that all cables are connected to defined ports.
- Over speed of vehicle is not recommended. To get high point density average speed of 20-30 kmph is preferred.

D) Standard Operating Procedure for operating the Falling Weight Deflectometer (FWD)

i) Purpose

To determine the strength of existing Flexible Pavement layers and to evaluate the strengthening requirements by Falling Weight Deflectometer (FWD) Test.

ii) Accessories for FWD Test

i) Six to Nine velocity transducers (geophones)

ii) Falling Weight Deflectometer apparatus.

iii) Theory

Falling Weight Deflectometer (FWD) is an impulse-loading device in which a transient load is applied and deflected shape of Pavement is measured using Displacement Sensors to ascertain the structural strength of the pavement and to determine the thickness of overlay required for sustaining the projected traffic load.

Based on the data collected from condition survey, the road length shall be classified into sections of uniform performance. Identification of sections of "good, fair and poor" performance may made separately for each lane and shoulders separately. The length of each uniform section is kept at a minimum of 1 km except in the case of localized failures section length restricted to 0.3 km.

Sub grade samples for FWD purpose, also shall be collected at each of FWD observation location. The entire project shall be analyzed for the calculation of Modulus of Elasticity of existing Pavement using KGPBACK software.

The resulting load-deflection data shall be interpreted through appropriate analytical techniques, such as back-calculation technique, to estimate the elastic moduli of the pavement layers. The back calculated moduli values of pavement are used for

i) The strength evaluation of different layers of in-service pavements

ii) The estimation of the remaining life of in-service pavements

iii) Determination of strengthening requirement.

Calibration of FWD

It is essential that load cell and geophones fitted in the FWD equipment are properly calibrated for getting accurate and reproducible results.

Static Calibration

As per IRC:115-2014, in preparation for commencement of project, the load cell(s) used in the FWD should be calibrated in a standard laboratory and the readings of the load cell(s) should be matched to those of the reference load cell. The readings of the FWD load cell(s) should be accurate to 2 percent of the reference load cell readings. The date of calibration of the load cell should not be earlier than 365 days from the date of structural evaluation of pavements using FWD. Absolute calibration certificate of the equipment used for the project shall be made available during the actual test at site.

Load Repeatability

As per IRC:115-2014, in order to study the consistency and accuracy of the test results obtained by FWD, load repeatability test shall be carried out before using the FWD. In this test, deflection and load data were measured on a level bituminous pavement surface, which is free from any cracks. The range of load applied shall be taken in such a way that it generates peak deflections in the range of 250μm to 600μm. The test shall be repeated for a minimum twelve times. The standard deviation of the peak load in the load repeatability test estimated should be less than 5 percent of the mean value of peak load which is achieved in the load repeatability test. Deflection repeatability check also to be conducted using the data collected in load repeatability test. The standard deviation of the normalized deflections, shall be less than 5% of the mean value of reading. Results of repeatability test shall be mentioned in the test report.

Interval of test points and Marking for FWD Test

The interval at which data should be collected will depend on the length of uniform section.

For example, if the length of section of uniform "fair" performance is 2.0 km, the maximum spacing at which deflections should be measured is 2000/15 = 133m. The spacing can be rounded off to convenient practical values.

Different measurement schemes can be adopted. These include i) measurement along the most distressed wheel path of the carriageway ii) measurement along inner as well as outer wheel

paths of all the lanes iii) measurement along both wheel paths of only the outer most lanes and iv) measurement along the more distressed wheel paths of each of the lanes. The guidelines given in below mentioned Table are recommended for selection of deflection measurement schemes for different types of carriageways.

Table: Guidelines for Selection of Deflection Measurement Scheme (As per IRC:115-2014)

Type of Carriage way	Recommended Measurement Scheme	Maximum Spacing (m) for test points along selected wheel path of different classifications		
		Poor	Fair	Good
Single-lane Two- way	Measure along both outer wheel paths	60	130	500
Two-lane Two-way Single Carriageway	Measure along both outer wheel paths	60	130	500
Four Lane Single Carriageway	Measure along the outer wheel paths of outer lanes	30	65	250
	Measure along the outer wheel path of more distressed inner lane	60	130	500
	Measure along the centre line of paved shoulder(in case of widening projects)	120	260	500
Four lane Dual(divided) carriageway (Measurement scheme given for each carriageway)	Measure along outer wheel paths of outer lanes	30	65	250
	Measure along the outer wheel path of inner lane	60	130	500
	Measure along the centre line of paved shoulder(in case of widening projects)	120	260	500
Dual Carriageways with 3 or more lanes in each direction (Measurement Scheme given for each carriageway)	Measure along outer wheel paths of outermost lanes	30	65	250
	Measure along outer wheel path of more distressed inner lane	60	130	500
	Measure along the centre line of paved shoulder (in case of widening projects)	60	130	500

Outer Wheel Paths of outer lanes

i) Mark a point at a distance of 0.6 m from outer edge of outer lane for single-lane two-way carriage way, 1 m from outer edge of outer lane for two-lane two-way carriage way and for divided four lane highway, the measurements points should be 0.75m from outer edge of outer lane.

ii) Repeat the process of marking points at an interval of (Based upon the Determined spacing for each uniform performance section).

iii) Outer Wheel Paths of inner lanes:

iv) Mark a point at a distance of 4.0 m from the outer edge of outer lane for multi-lane single carriageway, 4.2 m from the outer edge of outer lane for divided carriageways with two lanes in each direction and for divided carriageways with three lanes in each direction 4.2 m from the outer edge of outer lane for central lane and at 5.2 m from the outer edge of outer lane for the lane adjacent to median.

v) Repeat the process of marking points at an interval of (Based upon the Determined spacing for each uniform performance section).

Procedure: The following steps shall be followed for measuring the deflections at each test point.

1) Mark the test point on the Pavement as per the interval obtained from the Pavement condition survey.
2) Center the load plate of duly calibrated FWD over the test point.
3) Lower the load plate onto the pavement. There should be no standing water on the pavement surface. The loading plate should be in proper contact with pavement surface. If a non-segment plate is used the presence of rutting at test location should be noted if it affects the contact between plate and pavement surface. The longitudinal and transverse slope of the pavement should not exceed 10 % at the test location for accurate measurement of deflection.
4) Lower the frame holding the displacement transducers (geophones) so that the transducers are in contact with pavement surface.
5) Raise the mass to a predetermined height for producing a target load of 40 KN.
6) Drop one seating load. Load and deflection data for seating load drop need not be recorded.
7) Raise the mass and drop. Record load and deflection data into the computer through data acquisition system. While peak load and peak deflections at different selected radial positions must be recorded, complete time history of load and deflections shall be stored for each load drop if feasible.
8) Repeat the above step at least two more times.
9) Check whether the measured deflection is less than 10 μm. In such case, the test shall be repeated by changing the peak load.
10) Raise the geophones frame and load plate and move to the next test point.
11) Record air temperature at half hourly interval. Record pavement surface temperature if non-contact temperature sensors are available.
12) Deflection measurements should not be made when the pavement temperature is more than 45 °C. In colder areas and areas of altitude greater than 1000 m where the average daily temperature is less than 20 °C for more than 4 moths in a year, the standard pavement temperature of 35 °C will not apply. In such cases the ambient temperature is greater than 20 °C. No temperature is applied for back calculated moduli of bituminous layers.

Corrections and Analysis

Following corrections are to be applied to the FWD test observations during its analysis:

1. The pavement temperature and seasonal variation in Climate influence the deflections measured by the Falling Weight Deflectometer.
2. Measure Pavement surface layer temperature at half-hourly intervals by drilling holes of 40 mm depth into the pavement surface layer. Fill the hole with a drop of glycerol. Insert the thermometer into the hole and measure the temperature after three minutes. Correction shall be applied to the deflection measured in accordance with the procedure described in IRC:115-2014, if the observed temperature is different from 35°C.
3. The back calculated modulus of bituminous layer obtained from deflection survey conducted at a temperature "T2" °C can be corrected to estimate the modulus corresponding to a temperature of "T1" °C using below mentioned equation

$$E_{T1}=\lambda E_{T2}$$

where,

λ, temperature correction factor, is given as

$\lambda = [1-0.238 \ln(T1)]/ [1-0.238\ln(T2)]$

E_{T1}= back-calculated modulus (Mpa) at temperature T1 (°C)

E_{T2}= back-calculated modulus (Mpa) at temperature T2 (°C)

4. Seasonal correction is to be applied using the relationships developed for different seasons(Winter/ summer/ monsoon) given in the **Clause 6.5.2** of IRC:115-2014.

Reference: IRC:115-2014 "Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements using Falling Weight Deflectormeter (FWD) Technique"

E) Standard Operating procedure for Carrying out Road Inventory and Pavement Condition Surveys Using Network Survey Vehicle or similar equipment

i) Purpose

To determine the surface condition of the existing pavement and road assets (Road Inventory) by Survey Vehicle.

ii) Accessories

1) Laser Profiler
2) Transverse Profile Logger
3) Geometry Unit
4) GPS
5) Camera
6) Odometer

iii) Theory

The Network Survey Vehicle is based on the latest survey techniques utilizing Laser, Global Positioning System and Video image processing tools etc. The Survey Vehicle is used for automatic collection of road inventory and pavement condition related data required for Road Asset Management, Pavement

Maintenance Management System and Road Safety Audit related Studies. The system is capable of collecting the following information at Highway Speeds:

- Longitudinal Profile (International Roughness Index)
- Transverse Profile (Rut Depth)
- Road Geometry Data (cross slope, gradient, curvature)
- GPS coordinates (X, Y, Z) viz. longitude, latitude & altitude
- Video imaging for Roadside furniture/Road Assets
- Video imaging for Pavement Surface Distresses

iv) Survey Instructions

- The survey speed shall be within 30 to 80 kmph.
- The pavement surface shall not be WET during data collection using LASER sensors.
- The survey shall be conducted under good daylight conditions to have better video data.
- The survey system incorporates the use of LASER technique for data collection and so a trained operator on "LASER SAFETY" is mandatory.
- The survey vehicle shall only be driven by a "TRAINED DRIVER" for safety reasons.
- The system shall not be used on extremely bad road.

v) Procedure

The following steps may be followed for conducting the survey:

1) Conduct a test survey before start of the actual survey and check the individual parts of the equipment for its firm position and to ensure that the data is being recorded.
2) Process the test survey raw file and check the data for its accuracy.
3) Station the Vehicle at the start of the project stretch.
4) Start a new survey (enter the start chainage, direction of survey and section name).
5) Select the devices for survey that needs to be collected as per the project requirement.
6) Enter the Location Reference Post.
7) Open several popup windows relating to specific pre-selected tasks from survey setup menu.
8) Wait for the equipment to stabilize and start the survey.
9) Make sure that Laser Profilers, Transverse Profile Logger (TPL), GPS, Geometry and camera starts for collecting the data automatically with reference to the odometer.
10) Record the road assets and visual condition using Inventory and Condition key codes, simultaneously.
11) Make sure that, visual conditions are recorded as per the MoRTH guidelines and is at an interval of every 500 m.

12) Conduct Lane based survey, i.e. if the project section is a four-lane corridor NSV records data on each lane and in both increment and decrement directions.

13) Take necessary precautions & care while conducting the survey, that the vehicle always stays in the designated lane and no overtaking is performed while collecting the data.

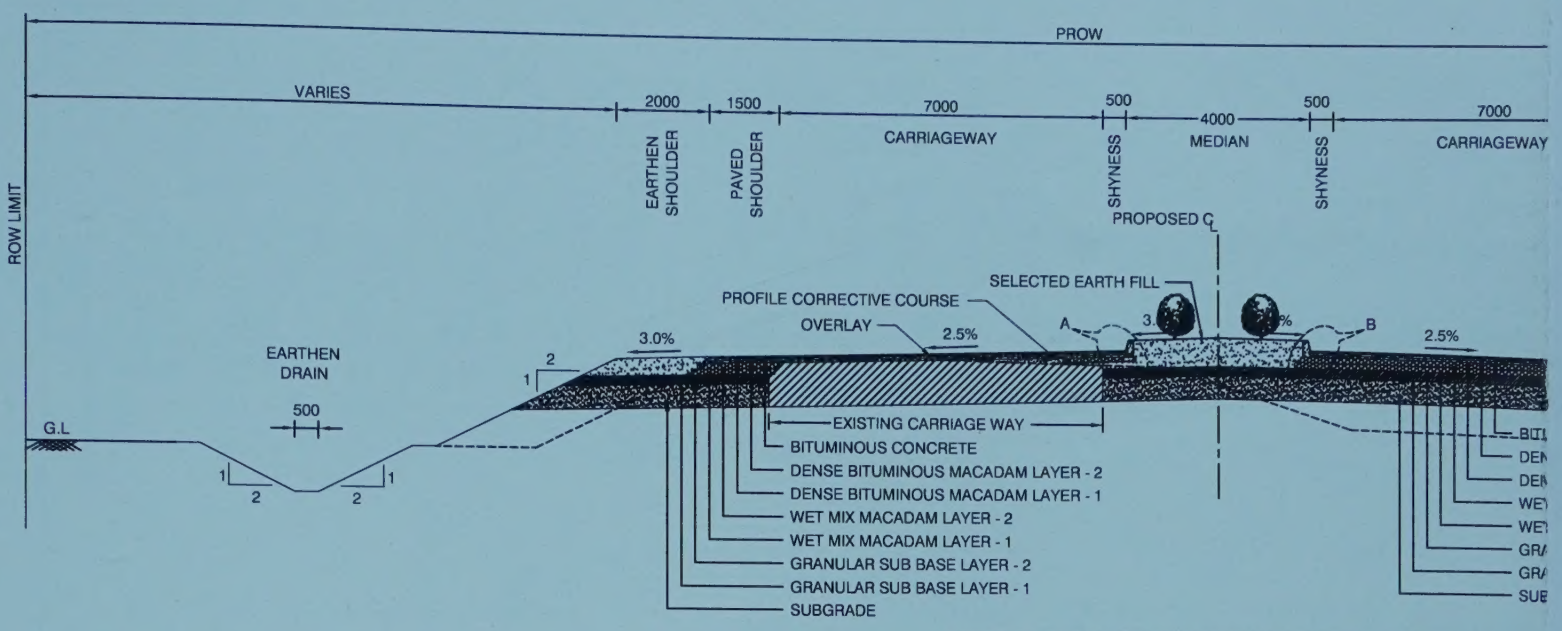
14) Similarly, make sure that the data is recorded till the section end and a Location Referencing Post is provided and the data is saved.

15) The Raw data collected from survey section shall be processed using the applicable software and the collected data is characterized as per the client requirement.

Pavement Condition Rating Based on Different Type of Defects:

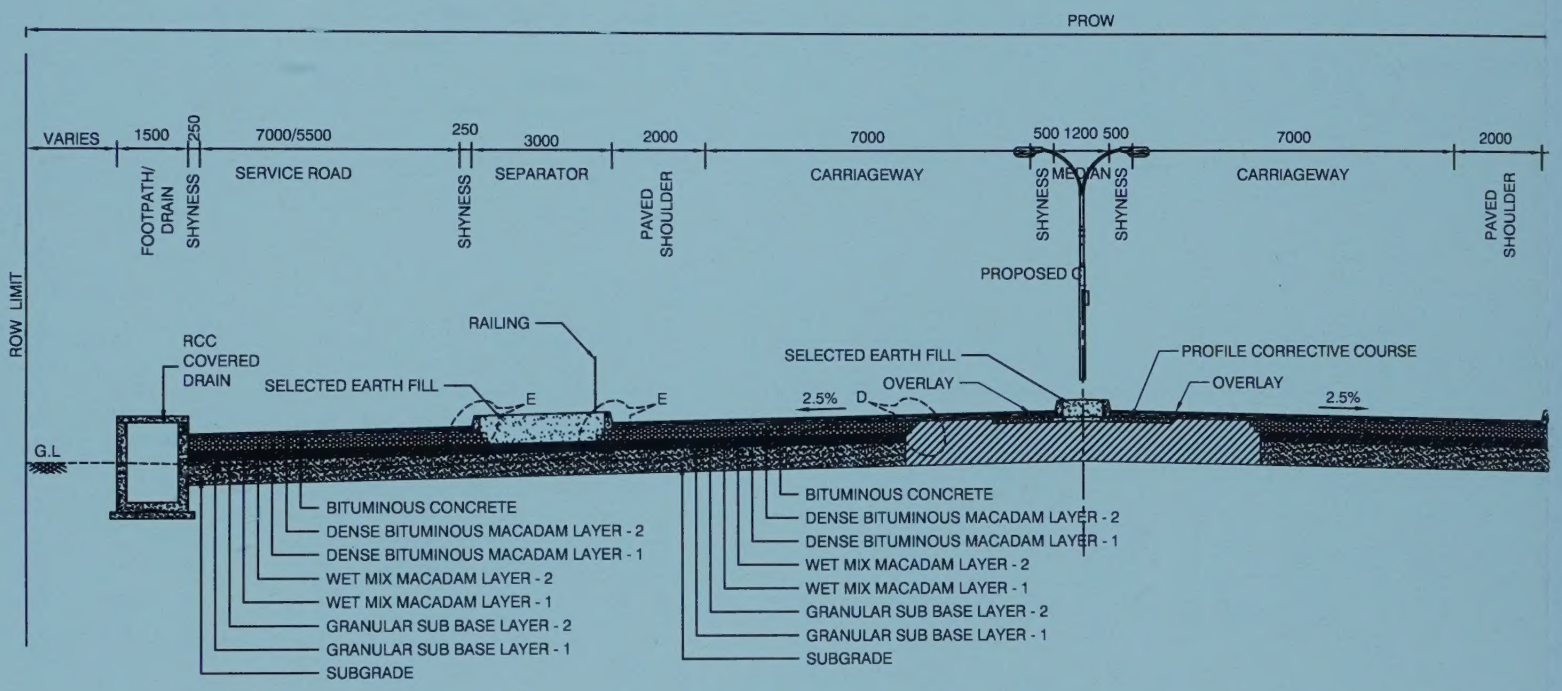
Defects	**Range of Defect (%)**				
Cracking	>30	21 – 30	11 – 30	5 – 10	<5
Ravelling	>30	11 - 30	5 – 10	1 – 5	0
Potholes	>1	0.6 - 1	0.1 - 0.5	0.1	0
Shoving	>1	0.6 – 1	0.1 - 0.5	0.1	0
Patching	>30	16 – 30	6 – 15	2 – 5	<2
Depression	>5	3 - 5	1 – 2	Upto 1	0
Rutting (mm)	>30	21 - 30	11 – 20	5 – 10	<5
Rating	1	2	3	4	5
Condition	**Very Poor**	**Poor**	**Fair**	**Good**	**Very Good**

Reference: Guidelines for Maintenance Management of Primary, Secondary and Urban Roads (Ministry of Transport & Highways) Published by: Indian Road Congress – Year 2004.



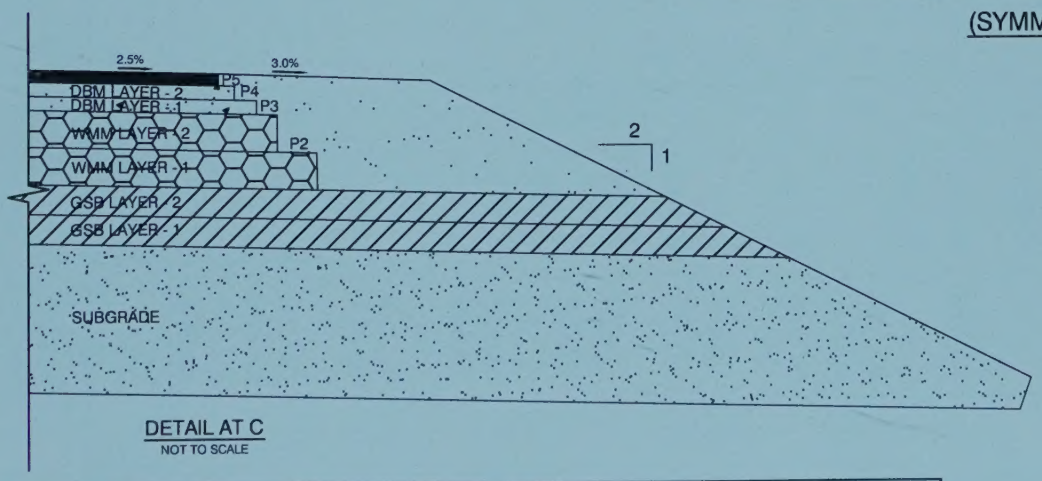
TYPICAL CROSS-SECTION IN RURAL STRETCH

(ONE SIDE WIDENING)



TYPICAL CROSS-SECTION WITH SERVICE ROAD IN BUILT UP AREA

(SYMMETRICAL WIDENING)



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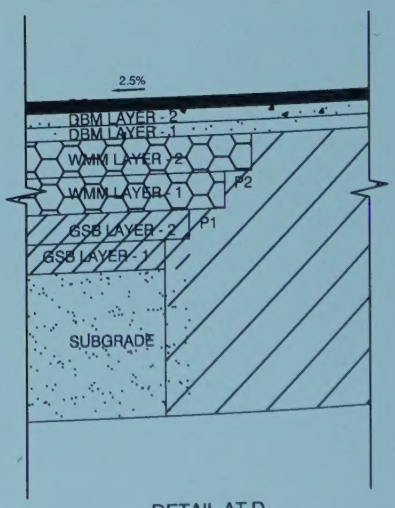

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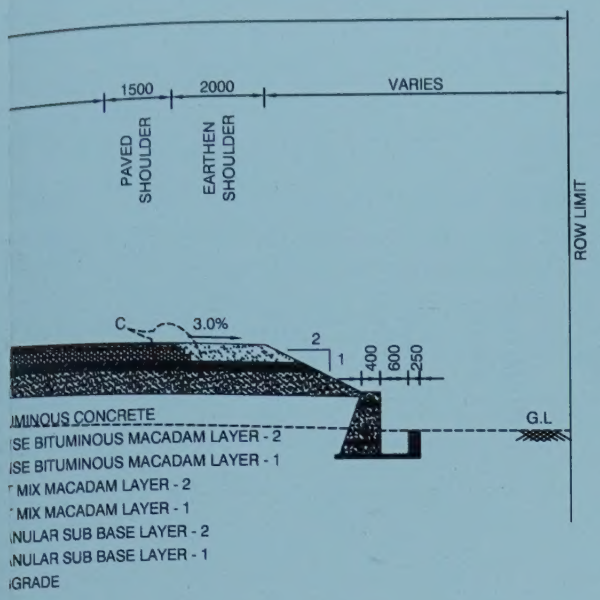
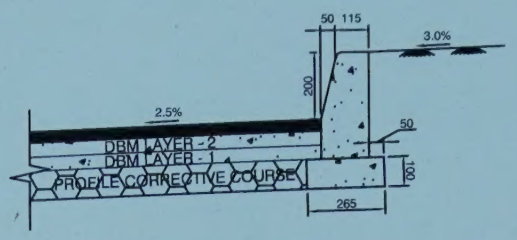
LEGEND





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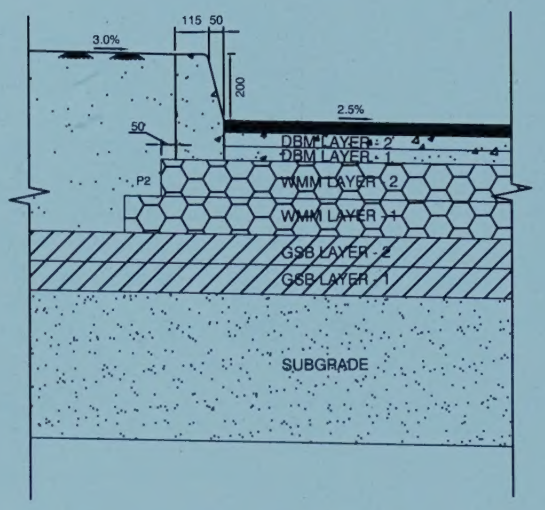

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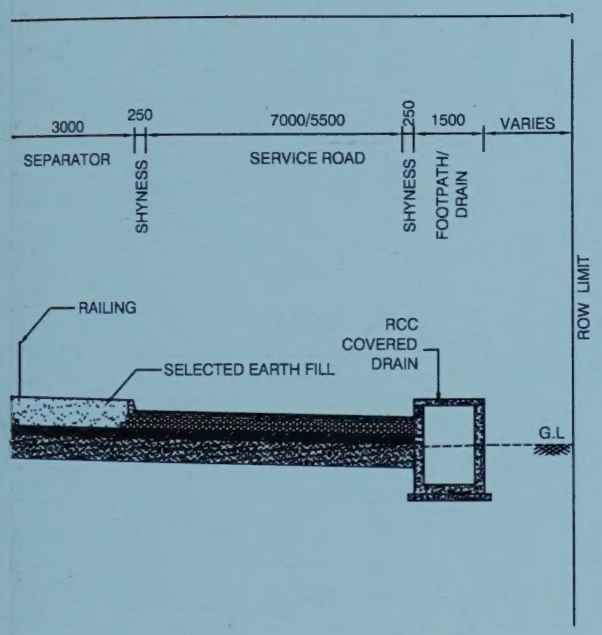

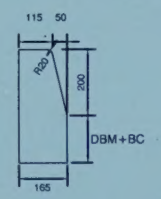

KERB
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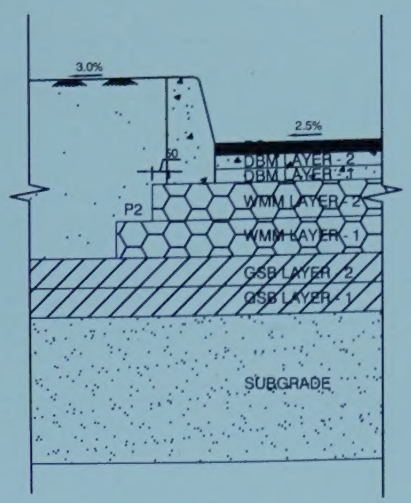

DETAIL AT E
NOT TO SCALE

P1 : WMM LAYER - 1
P2 : WMM LAYER - 2
P3 : DBM LAYER - 1
P4 : DBM LAYER - 2
P5: BC

Notes:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED
2. GRANULAR SUBABSE SHALL BE LAID IN SINGLE LAYER UP TO 200mm
3. KERB SHALL REST ON WMM/M-15 CONCRETE AND CONSTRUCTED BEFORE LAYING BITUMINOUS LAYERS.
4. P- THICKNESS OF CORRESPONDING LAYER.
5. PCC- PROFILE CORRECTIVE COURSE
6. KS- KERB SHYNESS SHALL BE AS PER APPLICABLE STANDARDS.
7. THE CROSS-SECTIONAL ELEMENTS ARE TYPICAL AND MAY VARY AS PER APPLICABLE STANDARDS

TYPICAL CROSS-SECTION FOR FOUR LANING WITH FLEXIBLE PAVEMENT

TITLE :

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/Manual, etc. from the date specified therein)

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